LETTER TO THE EDITOR

Sir:

The editorial in the November, 1943, issue of your magazine struck me as being very timely. The idea of amateur astronomers keeping abreast of other correlated sciences is quite pertinent to present-day situations. Oddly, this same month's issue of **QST**, a magazine for radio amateurs, contains an article on astronomy as related to radio problems and the same general line of thought seems to pervade the article.

The writer of this letter, who has been a licensed amateur radio operator for 10 years, had an interesting example of radio-astronomy several years ago. He was a member of a traffic net and on the occasion of a lunar eclipse the entire net, spread through several states, exchanged comments and descriptions of the eclipse with each other. Although that experience was only a passing stunt, it is quite possible that any amateur astronomers who are radio amateurs, or have friends who are such, could find a means of bringing together these two sciences.

Incidentally, any readers of **Sky and Telescope** who desire accurate time intervals can make use of the signals sent from the National Bureau of Standards, WWV, which have extremely high accuracy. These signals are available every minute of the day, except for certain "marker" minutes of silence and occur every second. Any person having a broadcast set tunable to 5,000, 10,000, or 15,000 kilocycles can receive these signals. [15,000 kilocycles is in daytime only.] The writer uses them constantly for watch-checking and is now planning a small portable receiver so that when rooftop observing is indulged in, a really accurate time source will be available. A column description of WWV schedules appears in almost every issue of **QST**, and further information may be obtained by writing to the Director, National Bureau of Standards, Washington, D. C. [**QST** states that during a winter day good service is given on 5,000 kilocycles at distances from 0 to about 1,000 miles, on 10,000 from about 600 to 3,000 miles, and on 15,000 from about 1,000 to 6,000 miles.]

It seems to me that the amateur in any science is finding that other sciences are necessary to his hobby. When the war is over and radio communication is possible for amateurs again, it may be that amateur astronomers who are also amateur radio operators may be able to embark upon some systematic means of bringing together the two sciences.

THEODORE R. SPRECHER, W3DXC
Ephrata, Pennsylvania

ED. NOTE: The article to which Mr. Sprecher refers is entitled "Astronomy and Amateur Radio," and was written by Hollis M. French, W1JLK, for **QST**, November, 1943. He says: "Now, while wartime restrictions hold ordinary hamming in abeyance, is the time to study the sciences of astronomy and aerology for their bearing upon communications."

Sky and TELESCOPE

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The Editors Note . . .

WARTIME conditions have not prevented our being able to maintain the quality and content of this magazine practically on its pre-war basis. This has been done, however, at a continually increasing cost. There has been an even greater rise in expense of distribution and circulation — although the number of subscribers has increased, the cost of handling each subscription has risen out of proportion to the increased income — and our past year's operations have incurred a sizable deficit.

These factors make it necessary to increase the annual subscription price to $2.50 for the United States and its possessions and for members of the armed services. Canadian and Pan-American subscriptions will be $3.00, and all other foreign subscriptions, $3.50. Single copies will be 25 cents.

This change will take effect for new subscriptions on March 1st, but for renewals or re-subscriptions by former subscribers on April 1st. Renewals beginning with the April issue will be billed at the new rate, but may be renewed at the old rate prior to April 1st. Before that date, however, all subscriptions, regardless of expiration, may be extended at present rates as far into the future as desired.

There will be no change in the rate of $1.50 paid by amateur astronomical societies which include **Sky and Telescope** as a privilege of membership, the cost being part of the dues of all members of each such society. The Amateur Astronomers Association, of New York, and the Bond Astronomical Club have thus supported the magazine for a number of years. These two organizations, together with the Rittenhouse Astronomical Society and the Cincinnati Astronomical Association, participate currently in this arrangement, and other amateur groups are invited to consider doing so as well.

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Whole Number 27

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FRONT COVER: Lt., j.g., T. A. Johnson, of Livingston, Ala., demonstrates the operation of the Pioneer Gyro Flux Gate compass, at the Philadelphia division of Bendix Aviation Corporation where it is in production for the Army and Navy. The compass transmitter is shown at the upper left on the tail of the plane; the amplifier is on the center of the fusilage; the master indicator is shown on the plane's nose, and a secondary indicator on the wing at the left. Courtesy, Bendix Aviation Corporation. (See page 7.)

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BACK COVER: A portion of the moon around the ring plain Archimedes, photographed by J. H. Moore and J. F. Chappell, using the visual focus of the 36-inch refractor at Lick Observatory, and originally appearing as part of the Lick Observatory atlas of celestial photographs. For a description of this portion of the moon, see "In Focus."

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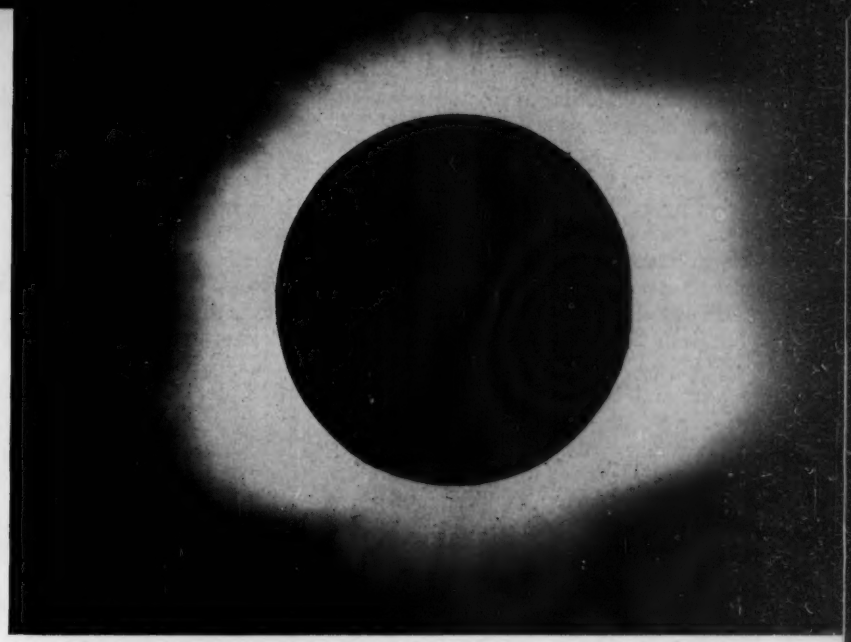
Eclipse in January 55 Years Ago

By J. Hugh Pruett

University of Oregon



The total solar eclipse of January 1, 1889, as photographed with the 13-inch Boyden telescope of the Harvard eclipse expedition.

"I CAN still hear him knocking at my bedroom door at two or three o'clock in the morning with, 'Daughter, the heavens declare the glory of God,' and at Leland's door, 'Son, the firmament showeth His handiwork.' This was grandfather's signal for us to get up to look through the old 6-inch telescope which he had inherited from his own Quaker grandfather."

Prof. J. Durham, president late last century of Washington College at Irvington, Cal., and the school's astronomy instructor, is thus fondly recalled by his granddaughter, Miss Georgia Cutler, who recently has been examining his correspondence and scrapbooks for material she is assembling for the Hoover library at Stanford University.

Prof. Durham reverently loved the starry skies and constantly inspired those around him with a similar affection. His daughter, Mrs. H. C. Ingram, relates that a group of seven college girls, including herself, called themselves *The Pleiades* from their admiration of the tiny asterism which had lent such "sweet influence" to their lives.

At the completion of the nearby Lick Observatory in 1888, Prof. Durham became greatly interested in its work. His acquaintance with Dr. E. S. Holden, the first director, was quite helpful in his being accorded an astronomer's reception at Greenwich Observatory when he visited England in 1892.

Mrs. Ingram recalls an interesting visit to Lick made by one of her father's classes in a caravan of three wagons. After highly successful observations, the party left the observatory at 11 p.m. At Smith Creek, part way down Mt. Hamilton, they camped for the night, all 30 sleeping on the ground in one long bed "with the chaperones in the middle."

One of the very interesting clippings found by Miss Cutler is her grandfather's account of his observation of the total solar eclipse of January 1, 1889. This was the occasion for expeditions from various institutions, most of them going to California, where the event occurred early in the afternoon. The path of totality came in from the Pacific Ocean somewhat north of San Francisco and ran northeastward almost to the Hudson Bay region in Canada.

Many reports on this may be found in the *Sidereal Messenger* for 1889. Lick Observatory sent its party to Bartlett Springs; Carleton College, to Chico; and Harvard and Brown Universities, to Willows, 120 miles north of San Francisco. The Pacific Coast Amateur Photographers' Association sent a party of 70 enthusiasts to Cloverdale where 167 pictures were taken. A special train was run from San Francisco, taking 300 excursionists to Norman where practically all were to view their first such eclipse. But the train was delayed and brought the sightseers to the zone of totality much too late to view the complete blackout.

Prof. David Todd, of Amherst, sent out several hundred copies of instructions to volunteer amateur observers along the path of totality in the United States and Canada. The abundance of responses from these indicated that practically the entire eclipse region was free from atmospheric disturbances, only about one per cent reporting interference from clouds.

It is thrilling to read Prof. Durham's own story written on the day of this eclipse and published shortly afterwards in a newspaper of his locality. Much of this is quoted below:

"Editor of *Express*. . . . Dear Sir: I came up yesterday that I might be in time to join the astronomers from Harvard University. Prof. W. H. Pickering was the chief of the party. He was ably assisted by Prof. S. I. Bailey, E. S. King and Robert Black, all of Cambridge.

"There are a number of instruments in this expedition. The finest is called the 13-inch Boyden telescope, which was used in the coronal photography of the eclipse. It is thought that the work of this telescope today has given the finest representation of the sun's corona that science has ever obtained, and if when the photograph is developed it is in any way different from previous pictures, it will for the present settle some questions in regard to eclipses.

"Besides this large instrument, they had two 8-inch telescopes for the purpose of photographing as best they could the details of the outer corona. They also had a 5-inch celestial photographic camera for obtaining the best possible views of the totality. Prof. Pickering called on me this morning and put this latter instrument in my charge and gave me two assistants. One of these was to make a record of the time of exposure of each plate; the other was to open the camera at my call, and close on the time of the vibrations of the seconds pendulum. My business was to manipulate the plates by the counts and call for times of exposure. We made 10 photographs in all, four of 10 seconds each and the others running as low as one second. The maximum time available was 115 seconds.

"There were several smaller photographic instruments in use that every possible means be employed to make as complete and perfect a series of observations as the occasion would permit. There was a large and newly improved spectroscope successfully used either to prove or disprove former theories of the spectrum analysis of sunshine during an eclipse. About 15 plates were secured from the spectroscope. This instrument was managed by Mr. Black.

"A few minutes before the moment of totality, Prof. Pickering, like a skillful and enthusiastic general, came to us, telling us what we might expect to see. He then exhorted all hands to keep steady nerves, be composed and stand by our posts. I observed, however, that he himself was quite nervous, which could not be otherwise as the whole scientific

world was watching his movements, and he and his assistants were there to contribute something to astronomical science.

"After our work was done Prof. Pickering said he wished a photograph of all the assistants, each at his post. It was stated that this scene would in due time appear in *Harper's Weekly*. There were some 20 assistants, all told. [Prof. Pickering in a later report gave 24.] Two San Francisco artists were present and took views of the grounds and the assistants at their instruments.

"We were deeply intensified with anxiety as the time for the first contact approached, because, while the north wind blew a little strong and cool, a long strip of cirrus . . . rose from the summit of the Coast Range, like a delicate lace curtain wrought by Nature's own handiwork. But this beautiful lacework was being gently drawn aside toward the east, so that the densest portion was nearly directly over the sun's disk when Prof. Pickering was ready to announce the first contact. Several degrees to the west was a large space of clear sky. . . . This space we watched with throbbing hearts and eager, anxious eyes. . . . Hundreds of persons stood about 100 feet from us — the limit for visitors — watching our movements and hearing the counts, each one supplied with the ever-ready smoked glass.

"I assure you, my dear sir, that it took most of my will power to keep a steady nerve when I saw that great shadow, 240,000 miles long, and knew that I was looking along that shaded path at the grandest wedding scene of all the planet world, gentle Luna and mighty Sol, the king of day. And when the cirrus curtain swung aside, all nature smiled, while to their right were fiery Mars and lovely Venus, and to their left were noble Mercury and omnipotent Jupiter, all bright, dazzling attendants of the nuptial scene.

"I was over anxious to see another planet whose existence is somewhat hypothetical, but they have gone so far as to name it Vulcan, the blacksmith god. It is intermercurial in position, yet there is some doubt as to its existence. Prof. Paine, who thinks he discovered it in 1878, had his expedition at Chico, to prove, if possible, his former discovery.

"The mountain peaks in every direction are covered with snow except to the south. While the shadow skipped over the Coast Range and for a moment darkened the summit of Snow Mountain, the Sierras to the east presented a peculiar appearance. It was not like sunrise nor sunset, but was a great halo of sunshine from a mid-day sun on a long range of minarets, glistening with a crystalline beauty. Old Mt. Shasta, 180 miles to the north, from a clear sky held aloft his head more than 14,000 feet in mid-air. . . .

"One of the principal instruments to be tested during the eclipse was a spectroscope of a peculiar form, devised by Prof. Pickering, for the analysis of sunlight. This one is known as the quadruplex spectroscope. But in closely examining all its parts and additions and in conversation with Prof. Bailey we concluded that they have gone beyond that by two more lenses, and hence we must call it a sextuplex instrument. The professor was very anxious for the results of this instrument.

"Probably the information as to the corona is of as great interest as anything in today's work. Mr. King had me sketch how it appeared to me that it might be compared with others. There is no doubt that it is simply a solar phenomenon, produced by the influence of the sun's heat on the surrounding solar atmosphere. It has never been witnessed excepting during a total eclipse. Astronomers have devised various instruments for that purpose, and hence it is expected that new developments will be made.

"Prof. Pickering hopes in this instance to get a view of the supposed planet Vulcan by one of his instruments, thinking that one may photograph it. Few of these photographs will be developed until they return to Harvard.

"The large Harvard instruments are placed on a brick foundation of about five feet in height with all the electric clock attachments in order to move the equatorial with the earth's movement.

"Prof. Bailey informs me that he goes from here to South America, near Lima in Peru, where he will spend about two years in taking observations and measurements of stars in the southern hemisphere.

"Just before departing, I called to take leave of the astronomers. Prof. Pickering called me to examine the third picture I took with five seconds exposure. He was delighted with it, it being, he assured me, eminently successful. He took my address and will send me one as a memorial of our mutual interest and association in this, one of the grandest sights of nature."

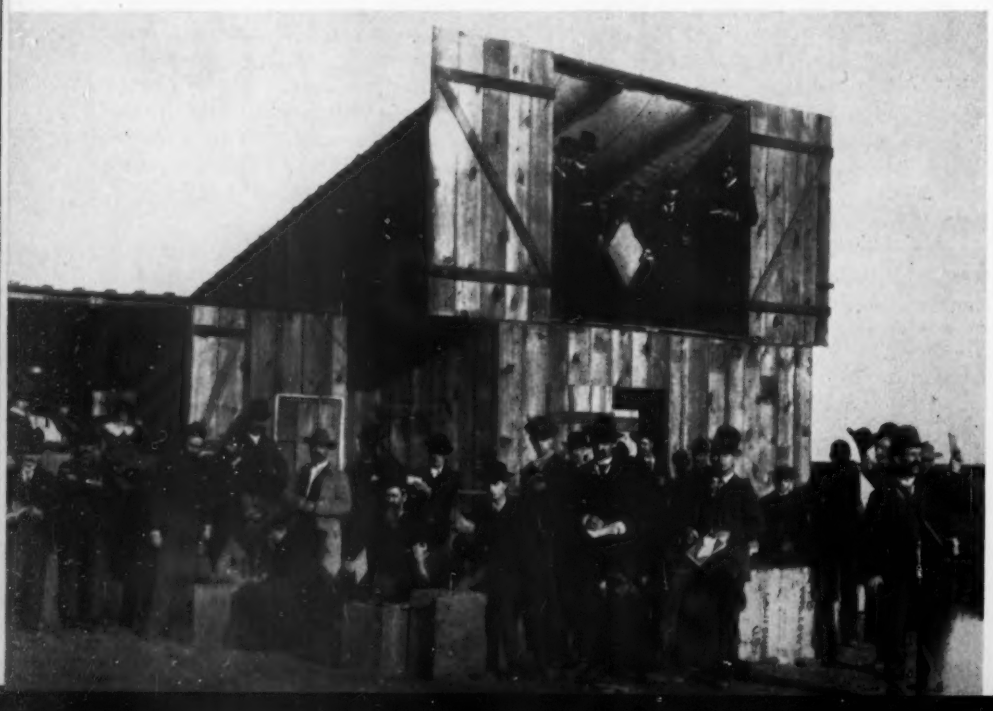
This interesting and beautiful description is far more than a mere account of a scientific event. It reveals unmistakably the poetical and religious nature of the writer and his genial friendliness toward all his fellow men.

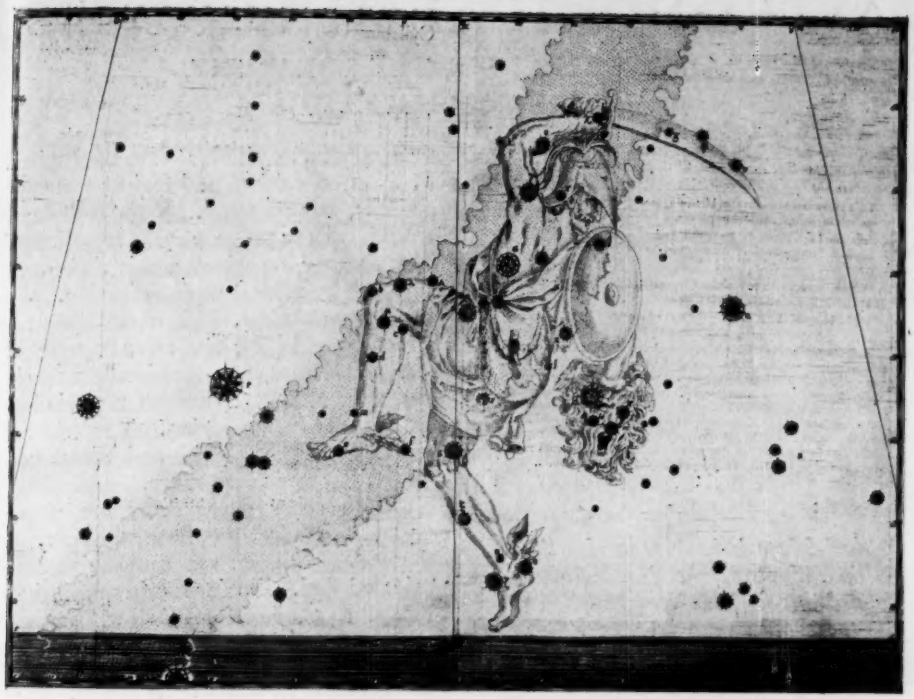
Prof. Durham left the teaching profession during the latter part of his life, but remained active in the ministry of his church until his death in a railway accident (in 1914) at the age of 78. About a year earlier he had built a little chapel at Clay, Cal., where he had preached on the morning of the fatal occurrence.

In this chapel a yearly memorial service is still held in honor of its beloved founder. A newspaper account of the latest service says this of it:

"The little chapel, built 30 years ago, is a gem in church architecture, the whole interior in brown stained wood and its 18 pews in lighter tones of brown. A large drape, an oil painting of Palestine, hangs back of the pulpit. A lovely little organ has been there through the years keeping silent vigil. The community in which the church was built has moved away and the trees have grown up around it. It is indeed a Church in the Wildwood now. This year over 100 people who love it still came from different parts of California to pay their tribute of honor and respect to the memory of its founder."

In this picture of the eclipse party at Willows, Cal., Prof. J. Durham is seated in the front row; he has a long beard and wears a "stove-pipe" hat. W. H. Pickering is standing in the front row, third from left, looking down, wearing a cap. Next to him is S. I. Bailey, with heavy beard and wearing a hat. From a lantern slide in the Harvard collection.





Perseus, as he appears in Bayer's "Uranometria"; in the lower left is Auriga, and to Perseus' right, a part of Andromeda.

STARS OF A WINTER NIGHT

By William H. Barton, Jr.

The stars of the winter season are among the brightest of the year; their story is told in the Hayden and Buhl Planetariums this month.

THE POLYNESIANS of long ago had a way of associating stars and places, an idea which was the basis of their ability to navigate the seas surrounding their island homes. The sky is divided into areas that we call constellations, just as the map of the world is marked off into countries and states. It is easy, however, to think of a constellation as a group of stars; in fact, that was the original conception. Sometimes only a few features are representative of a whole country. There is an analogy, then, between a map of the earth and a map of the sky. One is on the terrestrial globe and the other on the celestial globe. The latter is purely imaginary, but it appears to be a star-studded globe, inside which spins the terrestrial sphere. Observers on the earth looking straight up above their heads see stars or constellations that pass through their zeniths. What one may see at any moment depends upon his station on the earth, the date, and the hour of night.

Suppose we could stop the earth's spinning on January 15th at 10 p.m. Eastern war time. In the Central time belt the clock would be striking nine, while out in the Rockies it would be but eight o'clock. On the Pacific coast seven o'clock would be striking. What would the sky be like at that moment?

Exactly over New York City you will find the constellation Auriga. Somewhat to the east are three dim stars forming a thin triangle, and a little to the northeast a very bright star. These all belong to Auriga. The three stars that form the triangle are sometimes called the Kids and the bright star is Capella, the little She-goat. The point of the triangle, the star nearest Capella, is Epsilon Aurigae. This star broke into the news a few years ago because it has a ghostly, invisible companion that circles it and dims it out once every 27 years. The visible star changes from magnitude 3.4 to 4.1 in this period.

Observers in other parts of the country looking toward Capella are facing New York just as truly as though they were looking at a light on the top of some super Empire State building whose tower reached above the clouds and out to unimaginable heights among the stars.

An hour earlier the star was shining over mid-ocean southeast of Nova Scotia. An hour later, it will shine above eastern Ohio. By then it will be 10 o'clock there and 11 in New York. Another hour and it will shine over Nebraska; an hour later, over Utah not far from Salt Lake City, and then out across the Pacific.

A very well-shaped pentagon may be made out of Capella and four neighboring stars to the south and east. The southernmost star is merely borrowed for this celestial geometry. It belongs to the neighboring group of Taurus, the Bull, one of the zodiacal constellations. The star is called El Nath (*the tip*) and is associated in the old mythological picture with the tip of the long horn of the Bull. The other tip is to the south, on a line extended from one side of the V-shaped cluster known as the Hyades. One star in this constellation is very bright, Aldebaran, by name. Al debaran means *the follower,* referring to its trailing across the sky behind another very well-known cluster, the Pleiades, or Seven Sisters, just to the northwest.

El Nath will fly across the country over the peninsula of Florida, across the Gulf, missing the mouth of the Mississippi River by a few miles, over lower Texas, Mexico and Lower California to the Pacific. Aldebaran is so far south that it will pass overhead across Guatemala and the tip of Mexico.

South of Taurus and slightly to the east is Orion, the most beautiful of all the star groups we see on a winter night. Somewhat low in the sky even at its best in middle latitudes, its stars twinkle and sparkle like diamonds. The three stars in Orion's belt — Orion is the great hunter of the sky — form what is sometimes called the "yardstick" because its length is almost exactly three degrees. Look at it and learn to judge angular distance on the sky. The mid-star is Alnilam, one of the navigation stars, and the western end, Delta, is almost exactly on the equator of the heavens. It will, therefore, pass overhead along the earth's equator.

North of the belt you will see Betelgeuse and Bellatrix; south of it, Saiph and Rigel. These form a roughly rectangular figure. The whole region is marked by lines of stars, nebulae, and interesting objects for the small telescope.

At 10 o'clock, when Epsilon Aurigae is nearly over New York, and El Nath many miles off the coast of Florida, Betelgeuse is over British Guiana. Orion's belt is over the jungles of Brazil, while Rigel is nearly above Peru.

To the east of Taurus, southeast of Auriga, you will find Gemini, the Heavenly Twins. This is a constellation of the zodiac, the one in which the sun reaches its northernmost point

about June 22nd. It has two bright stars, Castor and Pollux, the two celebrated twins of mythology; Castor is to the north and Pollux to the south. The former is a very fine double star in even medium-power telescopes. The spectroscope further divides this naked-eye star.

Southeast of Gemini is Procyon, the little dog star. More people know the star than the constellation to which it belongs, Canis Minor, the Little Dog. The name means *before the dog,* referring to its position with respect to the brightest and most beautiful of all the stars in the sky, the Dog Star or Sirius. There will be no trouble locating this diamond, southeast of Orion and southwest of Procyon. Sirius is the nearest of all the easily seen stars visible from the mid-latitudes of our country. It played a most important role in the ancient religions, calendar making, temple building, and even today dog days, in midsummer, are named for it. The sun is in this region of the sky in that 40-day period. Sirius is so far south it passes across the Mato Grosso in Brazil, across Bolivia and lower Peru.

From Sirius you can no doubt find the Milky Way running northwest through Gemini, Auriga, and into Perseus and Cassiopeia. Perseus is not too conspicuous a group, but you may be able to trace out a script letter A among the stars, or a long curved line from the Pleiades to the W in Cassiopeia. Out where the center of that arc would be you may see Algol, that most famous of all variable stars, known to the ancients as El Ghoul, the Demon. Its winking characteristic was early recognized. Like Epsilon Aurigae, it is an eclipsing star; the period in this case is not 27 years but about two days and 21 hours. The star is generally of magnitude 2.1. In five hours it dims down to 3.2 and then in the next five hours comes back to its normal brilliance.

Cassiopeia is not of particular interest, except for the fact that it contains two navigational stars, the irregular variable, Gamma, and is just across the north pole of the sky from the Big Dipper. At 40° north latitude it is circumpolar. That is, it never disappears from the sky except with cloudy weather or daylight. It is closer to the pole than the horizon. Along this same Milky Way belt low in the northwest, Cepheus occupies an inconspicuous spot.

The Great Square of Pegasus is low in the west and the Sickle of Leo is just above the eastern horizon. The Dipper in the northeast stands on the end of its handle, the pointers leading to Polaris.

That is the sky of mid-January, perhaps the most beautiful of all the year. From latitude 40°, there are 15 stars that we might call "1st magnitude." At least they are brighter than magnitude 1.5. Nine of them are in this January sky. Beginning with Sirius low in the southeast, we can pick up Rigel, Aldebaran, with Deneb low in the northwest. Then we can return via Capella, Pollux, Procyon. Betelgeuse is within this belt, along the Milky Way. Only Regulus is outside, away off to the east and low in the sky.

Extended s o u t h w a r d , this belt stretches through the good ship Argo, the region of the Southern Cross, and other rich and beautiful skies that are below our horizon. Those stars, too, shine over the homes of our South American neighbors. Orion, the hunter or warrior, passes across that region where warriors are needed now, Micronesia and Polynesia, where many years ago this association of sky and earth had its origin.

ASTRONOMICAL ANECDOTES

AN ANCIENT JOKE, THE LUNAR SKY, AND MOON OBSERVATIONS

I SUSPECT that every astronomical lecturer at some time or other has told the story about the lady who comes up after a lecture and says, "Now I can see how you measure the distances to the stars, but how do you learn their names?" As early as 1900, in *Observatory,* the late beloved H. H. Turner called it "an ancient joke."

There is a new turn to it in a note in the British Astronomical Association *Journal* for May, 1931, when a correspondent quotes from a poem by Edith Sitwell:

And I heard the Margravine say
To the ancient bewigged Abbe
"I think it is so clever
Of people to discover
New planets — and how ever
Do you find out what their names
are?"

Maybe a good New Year's resolution would be not to use this one any more.

In the same issue of the *Journal,* the item just before the one quoted has to do with what one could see from the surface of the moon. This is a quotation from the *English Mechanics,* where F. O. B. Ellison disputes the common statement that even during the lunar daytime a great display of stars could be seen, because of the lack of a lunar atmosphere. Says Mr. Ellison:

"During a total eclipse of the sun, the faintest stars are not visible. . . . The reason is not the light in the sky, but *because the eye is light adapted.* In strong sunshine the human eye is only 1/500th as sensitive to light as it is in a dim light, or even less. . . . Go out on a clear dark night and look at the hosts of stars visible. Now imagine all the stars reduced to 1/500th part of their former brilliance, how many of them would be visible? Venus, Jupiter, Mars at opposition, and Sirius; Canopus possibly, but no more. Vega and Rigel would appear of the 7th magnitude! Try another experiment, this time quite easy and requiring no imagination. Go indoors on a clear, dark night, open the window wide, switch on a couple of (bright) lamps, and stand well back in the room and look through the window at, say, the Orion region. You will see the belt perhaps, Rigel and Sirius certainly, but not much more.

"Two other experiments are worth trying. . . . Most people these days sport a wrist watch with a radioactive illuminated dial. Go for a trip on a bright day on some non-electrified railway where they do not turn lights on when a train goes into a tunnel. Try to read your watch in the tunnel. You can't. Next, set your alarm clock for 4 a.m.; when you wake up look at your watch, the same watch — the figures will simply blaze. . . . The difference is entirely in the eye."

Certainly, these ideas will make many of us a little more cautious in our statements about the looks of things as seen by day from the moon.

The moon was the cause of the founding of the Greenwich Observatory in 1676. If its position could be predicted with certainty, the moon would provide a means of determining Greenwich time when the observer was at sea. Even today, observations of the moon are considered very important at Greenwich. Sir George Airy guarded the tradition carefully, about a century ago. As Turner tells in his *Modern Astronomy* (1901), occasionally an assistant would have "some accident with an observation of the moon," perhaps through oversleeping on a cold morning; "Airy's rebuke would be conveyed in some such terms as these, written out on a piece of paper, and laid on the desk of the delinquent: 'The Royal Observatory was founded for observation of the moon. We get about 300 observations of the moon during the year in all; and the Observatory costs the nation 6,000 pounds a year. Hence each observation of the moon is worth 20 pounds; and by losing one last night you have cost the nation 20 pounds!' The effect of such a rebuke has been described as 'prodigious.'"

Almost a hundred dollars seems pretty high for one observation of the moon's position, whereas Dr. Harlow Shapley figured a few years ago that it cost only a few cents (I've forgotten the exact amount) to discover a galaxy!

R. K. M.

AIRPLANE COMPASS

The Gyro Flux Gate compass system overcomes many difficulties for aerial navigators.

RECENTLY, military officials permitted announcement of the development by Bendix-Pioneer engineers of a type of airplane compass which has many advantages over its predecessors. It is known as the Gyro Flux Gate compass, as it combines the action of the flux of the earth's magnetic field with a gyroscope designed to keep it horizontal in spite of maneuvers of the plane. It is far more sensitive than the ordinary compass and may be operated successfully near the earth's magnetic poles.

Existence of the instrument and its production in volume at Bendix Aviation Corporation's Philadelphia division has been revealed because one or more of the compasses are believed to have fallen into enemy hands. However, Bendix officials point out that "there is no possibility that the enemy can catch up with us because it will be impossible for them to duplicate the performance of this compass — much less put it into volume production during this war."

Because it is of the remote-indicating type (see front cover), and because a special cam compensator is employed, the Gyro Flux Gate compass gives a reading of magnetic heading that is highly accurate. The value of local variation may be introduced into the system, resulting in an indication of true heading requiring no interpolation of any sort.

When a turn is made, the compass shows immediately the direction in which it is being made, and does not lag or overshoot, nor oscillate during rough weather. Its freedom from deviation is obtained by a special built-in deviation compensator and by its being part of a system in which the compass itself may be placed in any favorable location on the craft, and in which the master indicator is directly at the navigator's desk and controlled by him.

Most important element of the system is the compass transmitter, containing the flux gate. This unit comprises three equal arms forming a triangle, each arm having a core of high-permeability alloy, and each provided with an exciting winding and a pick-up winding. Through the exciting windings an alternating current is passed continuously during operation. When the exciting windings are thus energized, the flux intensity of the earth's magnetic field causes an induced current to pass through a change from maximum to minimum during each half cycle of the exciting current. A pulsating current in the pick-up coil results, its frequency being twice that of the exciting current, and its amplitude exactly proportional to the amount of the earth's flux passing through that particular arm of the flux gate. Three signal voltages are thus obtained, the relative values of which depend upon the azimuth relation of the flux gate to the earth's directive magnetic horizontal component.

The flux-gate element of the transmitter is stabilized in the horizontal plane by a horizon gyro. The gyro head contains a rolling ball type of erection system which tends to maintain the gyro in a vertical plane by setting up a restoring force which is a function of the amount of displacement of the gyro axis from the vertical.

The second unit of the system is the master indicator, of which one of the principal parts is the Autosyn. The three signal voltages, which are in general of different magnitudes, are conducted to three stator terminals of the Autosyn, within which they produce an alternating magnetic field. This in turn induces in the Autosyn rotor an alternating current — unless the rotor is at the null position.

The induced voltage is connected to a vacuum-tube amplifier to produce sufficient power to excite one phase of the induction motor. This induction motor is a two-phase unit having a stator wound in quadrature — the control phase being connected to the amplified signal of the Autosyn rotor, and the fixed phase receiving its power in identical frequency (twice that of the exciting current) from an oscillator located in the amplifier unit.

When both phases of the induction motor are energized, it develops a torque which rotates the Autosyn through a gear train. This rotation continues until the rotor reaches the null position. Then the voltage in the rotor drops to zero; the amplifier output also becomes zero and, since then only the fixed phase of the induction motor is energized, it develops no torque.

Thus, the position of the Autosyn rotor is determined by the angular position of the flux gate with respect to the earth's field. When this is changed, as when the aircraft changes its heading, the Autosyn rotor is rotated by the induction motor through the same angle — and in the same direction. The Autosyn unit is geared to the induction motor, which in turn is geared to the pointer shaft of the master indicator.

Variation correction is applied by rotating a knob on the face of the indicator. This knob offsets the dial either east or west until the desired variation

The periphery of the master-indicator dial contains cam-compensator adjustment screws, to correct for deviation. Pioneer instrument, courtesy, Eclipse-Pioneer division, Bendix Aviation Corporation.

is shown on the lower segment of the dial. Compensation for deviation is applied by adjustment of screws, arranged around the periphery of the dial, which control the contour of a cam plate. The pointer of the master indicator shows heading of the aircraft, while another scale, visible through a cutout at the top of the main dial, provides indication of the uncorrected heading (see illustration).

The position of the master indicator is relayed by a transmitting Magnesyn unit to from one to six Magnesyn repeater indicators, which may be installed anywhere on the ship: one for each pilot, one for bombardier, and so forth.

There is an adjustment which can be made for differences in intensity of the earth's horizontal magnetic field. The procedure to be followed in compensating the Flux Gate compass is basically similar to that employed in compensating the standard compass except for the difference in the type of compensator employed. Great ease of compensation is obtained by the use of a separate test transmitter, which makes it necessary to swing the ship in azimuth once only. If the maximum deviation is more than 15 degrees before compensation is begun, another location on the craft for the compass transmitter should be found in which it is less than this amount.

It is evident that this whole installation is more complicated and in certain respects more delicate than the ordinary aircraft compass. Its reliability under varying conditions; its reading of true compass directions; its turning with the ship; its auxiliary indicators; its greater sensitivity in polar regions; its ease of compensation; these all combine to offset the increased problems of installation and service which the Gyro Flux Gate system presents, and its use in United Nations planes is rapidly helping to reduce the number of accidents due to uncertainties in navigation.

THE PLANETARIUM

By Roy K. Marshall

Fels Planetarium, The Franklin Institute

PART III

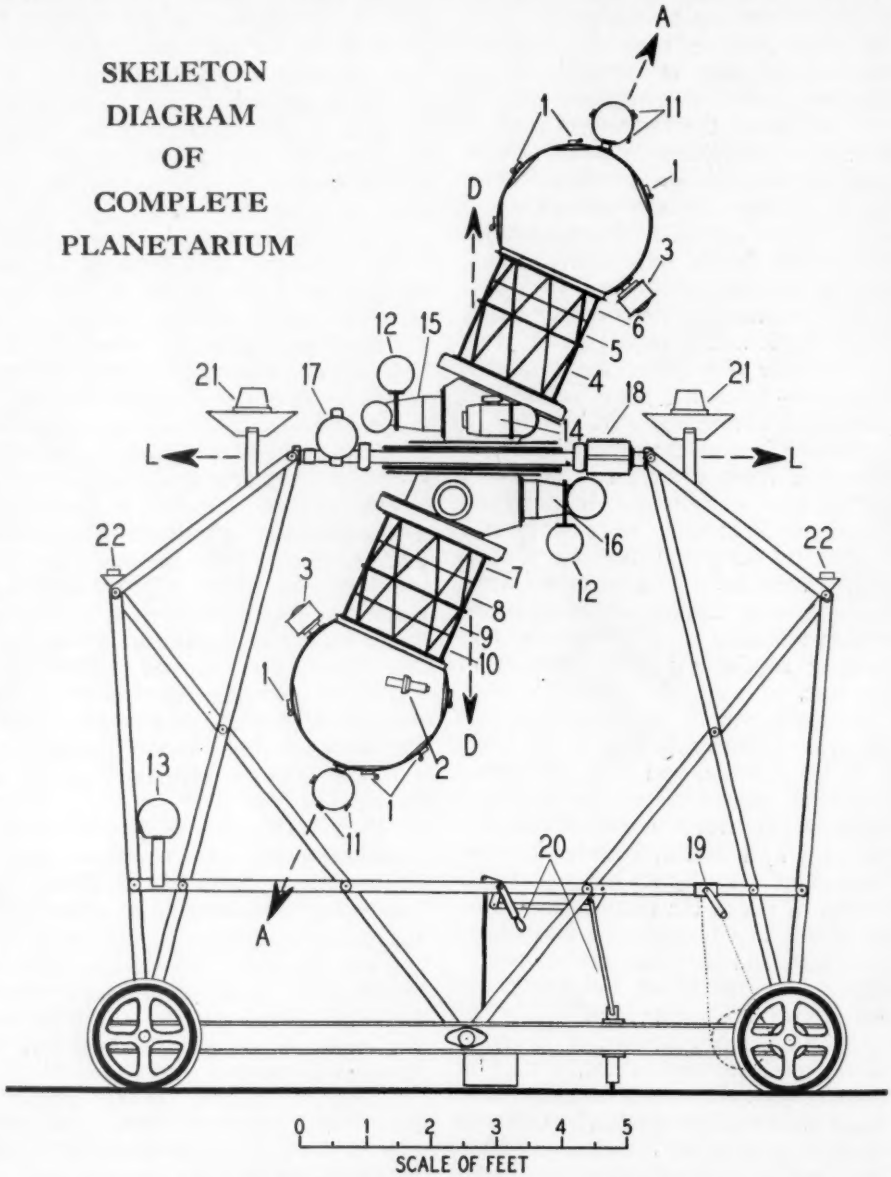
BY ROTATING the whole dumbbell portion of the instrument about the axis D—D (see diagram on the inside columns), the appearance of the rising, daily motion, and setting of each object is simulated. The motions of nature are accelerated; the phenomena of 24 hours are compressed into 10½ minutes, 3½ minutes, or one minute, as we choose. These are the approximate fundamental speeds in the Fels Planetarium; by combinations of these motions, other values are available, as will appear later. There are small differences in these speeds, from one instrument to another.

The whole moving portion of the instrument is slung on the axis L—L, which passes through the points of support on the structural framework. By rotating the mechanism about this axis, the change in the appearance of the sky as we journey northward or southward on the earth is reproduced. As we travel from home toward the equator, the stars in the southern sky stand higher and new ones come into view. We may go to the equator, cross it, traverse the Southern Hemisphere, cross the south pole, go up the other side of the earth over the north pole, and get back home again by coming down this side—all in only five minutes. Of course, we may halt anywhere, to spend as much time as we like in watching the stars for that place.

Strangely, comparatively few visitors inquire into the mechanism for reproducing the motions of the sun, moon, and planets, yet this is the only really complicated feature of the planetarium. The open, basket-like cages between the star globes and the large mass in the center contain two projectors for each of the five naked-eye planets (Mercury, Venus, Mars, Jupiter, Saturn) and the sun and moon. In the sun cage there are five other projectors: two for a glow of light or *aureole* around the sun's image, simulating the strong scattering of light which is seen in nature in the neighborhood of the sun; one for the *zodiacal light* which extends, lens-shaped, to either side of the sun for some distance, best seen in nature under excellent conditions after sunset in the spring or before sunrise in the autumn; and last, a pair of projectors for the image of the *gegenschein* or "counterglow," a diffuse faint patch of illumination directly opposite the sun's position among the stars.

In order, from north to south (top to bottom in the usual position of the instrument), the compartments of the cages are devoted to Saturn, the sun, the moon (above the central block); Mercury, Venus, Mars, Jupiter (below the central block). There are no projectors for the earth, quite naturally, for we are viewing the heavens as seen from the earth! Because there is a considerable number of struts and supports necessary to build up the cage structure, the projectors in this portion of the instrument need to be doubled, giving identical superimposed images, in order to prevent blinking of the images as the projectors are lined up with the supporting struts one after another. The struts of the cages and the main supports of the pedestal are made very thin.

In each compartment, a portion of an orrery provides the mechanism for keeping the twin projectors for the object di-



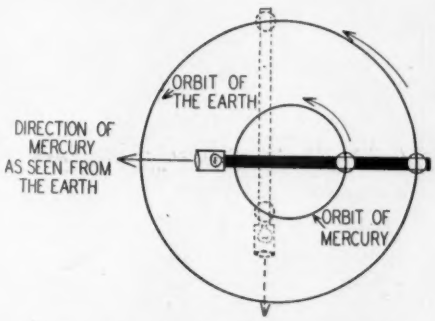
Projectors are located as follows: 1. Star fields; 2. Sirius, variable stars; 3. Milky Way; 4. Moon; 5. Sun; 6. Saturn; 7. Mercury; 8. Venus; 9. Mars; 10. Jupiter; 11. Constellation names; 12. Equator, ecliptic, portions of hour circles, parallels of declination, north and south celestial poles; 13. Meridian; 14. Year-counter. Motors are located as follows: 15. Annual motion; 16. Daily motion; 17. Change of latitude. The precession motor is on the other side of the instrument.

Other details are these: 18. Slip-rings for carrying current from pedestal to moving motors and projectors; 19. Crank mechanism for rolling the instrument along the track; 20. Handle for locking planetarium in position and closing multiple knife-switch carrying current from floor to pedestal; 21. Blue and white lights for illuminating planetarium chamber; 22. Horizon glow illumination. A—A: Annual motion and precession axis; L—L: Latitude change axis; D—D: Daily motion axis.

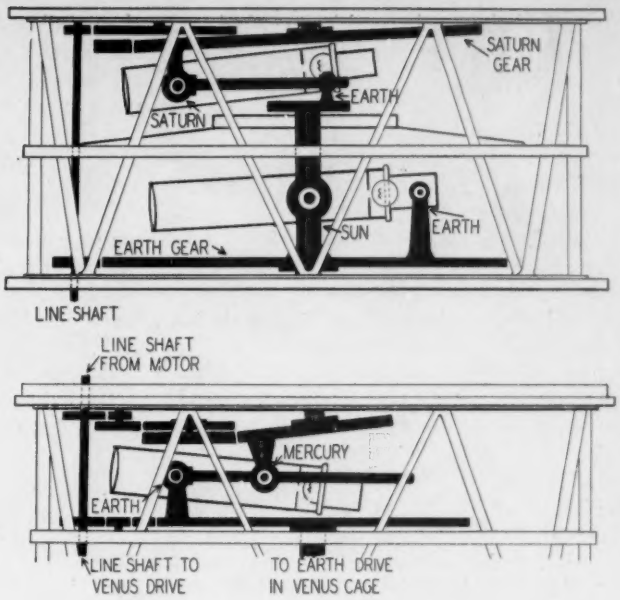
rected toward the proper point of the celestial sphere. For example, in the sun compartment the central pivot for the motion corresponds to the sun's position, and a point which revolves around this pivot represents the earth. If, now, a rod is used to join the fixed point representing the sun and the moving point representing the earth, and a pair of projectors is attached to this rod so as to point in the proper direction from the earth to the sun, the image of the sun on the dome will move as it should against the background of the fixed stars, in the course of the earth's annual journey.

In the moon compartment, the fixed point is the earth and the moving point represents the moon in its motion around the earth. For certain mechanical reasons, however, the pair of projectors has been attached to point from the moon toward the earth. To counteract this, the position of the moon has been set 180 degrees out of step, so the result is the image of the moon in the proper position against the stellar background.

In addition to the position of the moon, the phases must be reproduced by means of a clever occulting mechanism inside the complex optical system of the projector, so more space is required for the moon mechanism than for any of the others. Moreover, a complicated phenomenon known as the *regression of the moon's nodes* must be accounted for, so the whole moon projection mechanism is turned at such a rate that one revolution is accomplished in about 18.6 years, while the moon projectors themselves revolve once each lunar month. Because this *perturbation* of the moon's motion is included, the planetarium can be used in an approximate way to predict eclipses of the sun and moon. In order not to complicate the mechanism too formidably, however, eclipses are shown not by the planetarium, but instead by auxiliary apparatus designed and constructed by the planetarium staff and technicians.



A planetary mechanism reduced to its essentials. If a rod is attached to the two points representing, respectively, the earth and the planet (Mercury), it will point constantly in the direction of the planet as seen from the earth, whatever direction this may be. A projector on the proper end of this rod will cast a spot of light to represent the planet.



All gears for planet projectors take their motions from a line shaft passing through all the cages. Some economy is effected by using the same earth motion in two adjacent cages. Note that the gear which carries the Saturn-point is tilted with respect to the earth motion, for the orbit of Saturn is inclined slightly to that of the earth. In addition to this relative inclination, however, all projectors must be tilted to compensate for their location to one side of the central mass of the instrument. Saturn and the sun, above, and Mercury, below, are tilted in opposite directions because they are on opposite sides of the central mass. In addition, the inclination of the orbit of Mercury is greater than that of Saturn. Both Mercury and the earth are set 180 degrees from their correct positions, so the result is the correct position of the planet as seen from the earth.

In each of the compartments for the planets Mercury, Venus, Mars, Jupiter, and Saturn, there are three parts of an orrery represented. The sun is the fixed central point; one set of gears moves a point representing the earth, while a second set of gears moves another point corresponding to the other planet. As in the sun and moon compartments, the gearing is attached to a line shaft which leads from the motors bolted to the central mass of the instrument and runs through all the cages or compartments.

In each planet compartment, the motions of the earth-point and the planet-point must take place at the proper relative rates and at the proper relative distances from the central point, the sun. In nature, the planetary motions are elliptical, not circular. A fair first approximation to the true motions could be accomplished by uniform circular motions, but in the projection planetarium an even greater proximity to truth is gained by offsetting the centers of the planetary motions by a slight but carefully calculated amount. That is, the centers of the earth motion and the planet motion and the position of the sun do not coincide, for the sun is out of center in each planetary orbit by a different amount and in a different direction.

If one moving point represents the earth and the other one the other planet, we may look from the earth-point toward the planet-point, to see the direction in which the planet should appear to be. So we may use these two points to support a sliding rod, and attach a pair of projectors to the rod; the projectors will then cast images in the direction on the celestial sphere which is the direction of the planet as seen from the earth. As with the moon, however, the systems of Mercury and Venus are reversed, and the projectors are attached apparently to point from the planet toward the earth. The images come out at the proper places, however, and that is all that matters. To avoid possibility of confusion with each other and with other objects, Mars is shown red, and Jupiter and Saturn are given the appearances they present in small telescopes.

To derive the numbers of teeth in the gears for his mechanical planetarium or orrery, Christian Huygens invented the mathematical process known as *continued fractions*. Each gear train in each cage (one for the earth's motion, one for the planet itself) has been calculated by this method to yield a final value very close to the true one. For example, the period of the earth's revolution around the sun is actually 4.15209106. . . times Mercury's period; in the planetarium, seven gears are used to derive a value of 4.1520905 for this ratio; the error is only 13½ millionths of one per cent! Because of this approximation, the average position of the Mercury image will deviate from its proper place by one degree (two moon-diameters) only after the passage of 5,000 planetarium years. This is performance of greater accuracy even than our genuine knowledge of the future motion of Mercury. But it must be understood that this is the degree of perfection of the mechanism only on the average. At any given instant, because of various accumulated errors (such as the failure to reproduce exactly the elliptical motions of the planets), any planet may stand a degree or so away from its true position; this is not too serious when we are thinking only in

terms of observations with the naked eye.

Three motors can be used to drive this interlocked assembly of projectors for the sun, moon, and planets independently of the daily motion. That is, we may let the rotation of the earth cease while we race through the months or years, forward or back, to see these "wandering stars" of the ancients take up their collective successive positions. A year may be compressed into approximately three minutes, one minute, or five seconds, by rotating the whole planetary mechanism inside the cages around the axis A—A. Again, as for the daily motion, these speeds differ slightly from one instrument to another. But if we wish to observe the changes from night to night in leisurely fashion, we may use the daily motion previously described, and the planets and the sun and moon will automatically be pulled to their new positions by an interlocking system of gears and differentials.

One further motion remains to be described. The earth spins as a great top, and, like all tops, as it spins it "wobbles" —the axis of the earth points in different directions but comes back cyclically to the same position in a period of 25,800 years. This motion of a top, and of the earth, is known as *precession*. For us, it amounts to a change of the North Star, for if the axis of the earth points in different directions it will point toward different stars, and most of the time toward no star at all. In our time, the point of the celestial sphere toward which the north end of the earth's axis is directed is near a moderately bright star called variously Polaris, the North Star, or the pole star. But in 3000 B.C., the pole star was Thuban in Draco, and in 13000 A.D. it will be Vega in Lyra. As the pole star changes, the rest of the sky is shifted as well, so that some stars not now visible in the United States will be seen, and the rising and setting places of all stars will change.

This precessional cycle is reproduced in the planetarium by rotating the whole dumbbell portion of the instrument (and not merely the mechanism inside the cages) about the axis A—A; in a minute and a quarter we can pass through the whole cycle of 25,800 years required for one "wobble" of the earth's axis.

Again, however, we can run ahead by years, or even by days, with the other motors, and the precessional effects will be carried along. This implies a tremendous range of gear reduction in the instrument; the ratio between one precessional cycle and one day is almost 9½ million to one! But the situation is even more striking when we realize that in turning the instrument through one day in 10½ minutes, the motor shaft turns about 16,800 times; if this daily motion were continued until one precessional cycle should be accomplished, the motor shaft should have turned more than 158,000,000,000 times. It is unlikely that this will ever be done, for more than 188 real years would be required; most of the 190 gears and 220 ball bearings in the instrument would be quite worn out long before the job could be accomplished.

To summarize the motions available, we may use as a typical installation the instrument of the Fels Planetarium; the exact times for the motions differ slightly from one instrument to another. In addition to one precessional cycle of 25,800 years in $1^m\ 15^s$, and one trip around the earth (24,800 miles) in $5^m\ 8^s$, we have the following:

One day (24 hours) in $10^m\ 30^s$, $5^m\ 15^s$, $3^m\ 30^s$, $3^m\ 12^s$, $2^m\ 37^s.5$, $1^m\ 36^s$, $1^m\ 4^s$, or 48^s.

One year in $3^m\ 3^s$, $1^m\ 31^s.5$, $1^m\ 1^s$, $45^s.75$, $6^s.85$, $6^s.41$, $6^s.20$, $6^s.00$, $5^s.80$, $5^s.62$, $5^s.45$, $5^s.30$, or $5^s.15$.

TO RETURN to the projectors: The small globes at the ends of the large star globes contain projectors for the names of the constellations and projectors for the precessional circle, on which the years of the cycle are marked off in chiliads. Two similar small globes on the central block of the planetarium contain projectors for the celestial equator, the north and south celestial poles, portions of the parallels of declination and hour circles (like the parallels and meridians on a terrestrial globe), and the ecliptic, the sun's annual path among the stars. The ecliptic is marked off and labeled by months and days, so we may set the sun at a particular mark and thus have the instrument set for a chosen date within the year. Another projector reveals the year which is being represented. Still another one, visible only to the operator, indicates the latitude or place on the earth for which the instrument is set. Two more small globes on the supporting framework contain the fixed projectors for the celestial meridian, which splits the sky into eastern and western halves.

To sum up, 33 lamps feed 105 permanent projectors (containing more than 500 separate lenses) in the planetarium, divided as follows:

32 star-field projectors
1 for Sirius
3 for variable stars
2 for the Milky Way
7 for the sun, aureole, zodiacal light, gegenschein
2 for the moon
10 for the planets Mercury, Venus, Mars, Jupiter, Saturn
30 for constellation names, precessional circle
12 for equator, ecliptic, hour circles, parallels
4 for the meridian
1 for the year counter
1 for the latitude indicator.

All the motions and all the projections are controlled from the speaker's rostrum at the north side of the planetarium chamber. At that location all the switches and rheostats, including those for varying the general illumination of the room, are collected. In addition, numerous other switches and controls are provided for the special effects which from time to time are installed and used for purposes not provided for originally. Among these may be mentioned the constellation pictures, the northern lights, a comet, an eclipse projector, and the controls for the sound system which provides the introductory, incidental, and sunrise music. A small projector held in the demonstrator's hand is used to project the image of a luminous arrow on the sky, to point out any specific object.

The planetarium is mounted on wheels, so the whole mass of about two tons may be rolled across the room on a track, for servicing the floor beneath it, or to make the room available as an unobstructed auditorium seating more than normal. During a demonstration in any planetarium, the instrument is firmly locked into position.

In the planetarium chamber the visitor sits in comfortably air-conditioned darkness and listens to the lecturer as he puts the instrument through its performance. The motors hum softly and as if by magic the stars roll overhead. No streaks of light are seen leading from the planetarium to the dome, for the air is washed and clean. In most demonstrations a change of pace is provided by lantern slides and auxiliary apparatus which illustrate specific points of the topic under discussion. In those institutions where the dome is made of perforated steel, certain very interesting effects can be obtained by arranging tableaux behind the projection surface. On occasion (and especially at the Christmas season), demonstrations of highly dramatic nature have been presented; a trip to the moon, during which the audience sits in a startlingly realistic reproduction of a lunar crater, has been featured many times.

By changing the topic, usually at the beginning of each month, the whole field of astronomy can be explored, with but little repetition. Whatever pertains to astronomy and man's appreciation of the mystery and beauty of a starry night is appropriate material for presentation in the planetarium chamber. In describing the Adler Planetarium, its first director, Dr. Philip Fox, concluded with these words: "The visitors come to see a stirring spectacle, the heavens brought within the confines of museum walls. Not a trivial plaything, a mimic aping firmament, but the heavens portrayed in great dignity and splendor, dynamic, inspiring, in a way that dispels the mystery but retains the majesty."

NEWS NOTES

By Dorrit Hoffleit

MORE ON THE DOUBLE CLUSTER

In his recent doctoral thesis written at Yerkes Observatory, Dr. William Bidelman has made a spectroscopic study of stars in the region of the Double Cluster in Perseus. Clusters always "grow" with intensive study: stars farther from the center than we should judge from visual inspection alone are found to be cluster members. The membership of a given star is most conclusively ascertained from its common motion with that of the cluster as a whole. When data on motions are not available, the spectroscopic evidence is very helpful, because the spectral characteristics tell the absolute luminosity of a star pretty accurately. From stellar luminosities, distances from the solar system are inferred. For stars to belong to the same cluster, they must be at the same distance from us within narrow limits.

Dr. Bidelman has examined 153 blue stars in an area of 10 x 15 degrees in the region of the Double Cluster. He found that the supergiant stars show both a pronounced concentration toward the cluster centers and a dispersion which indicates a diameter for the cluster of about five degrees. The distance of the cluster was redetermined to be 1,920 parsecs (6,400 light-years), whereas former estimates have been about 2,500 parsecs.

THE DARWIN LECTURE

On September 10th, Prof. S. Rosseland, of Oslo, Norway, delivered the George Darwin lecture before the Royal Astronomical Society in London, on the subject: "The Pulsation Theory of Cepheid Variables." Prof. Rosseland had until recently been at Princeton University, following his escape from Norway a couple of years ago.

The pulsation theory became famous in 1917-18 when Sir Arthur Eddington's work elevated it to the rank of a mathematical theory capable of quantitative predictions. If the pulsations in the atmosphere of a star were infinitely small, the product of the period of the light variation times the square root of the density should be constant. In Rosseland's own researches, finite pulsations are assumed which lead to an increase of period with larger amplitudes of the light variations. This helps somewhat to reduce some of the difficulties of the original theory. The war has put a temporary stop to Rosseland's work on this subject, but he hopes to be able to continue afterward.

He emphasized the present-day incompleteness of the theory. "The first approximation was pretty well worked out; but this approximation is not very satisfactory. The theory of finite pulsations was still in its infancy, but it was only by such a more exact analysis that we could hope to give an adequate description of Cepheid variability within the framework of the pulsation hypothesis."

LEMBANG OBSERVATORY

The British journal, *Observatory,* comments on a note in the *Monthly Notices* of the Astronomical Society of South Africa relative to the Bosscha Observatory at Lembang, Java:

"Apparently the Japanese in a broadcast stated that they had captured the best-equipped observatory of the East without a scratch, completely intact. This must refer to the Lembang Observatory, but as to the fate of the staff, all of whom had joined the Dutch forces, no information is available."

LUNAR ECLIPSES AND THE EARTH'S ATMOSPHERE

Through the efforts of the Committee for the Distribution of Astronomical Literature, we have received abstracts of numerous papers published in France within the past year. Several relate to the earth's upper atmosphere. Of particular interest is one on a photometric study of the eclipse of the moon on March 2-3, 1942, by Daniel Barbier, Daniel Chalonge and Ernest Vigroux. Certain bands due to oxygen molecules and ozone are characteristic of the moon in eclipse. A relationship is found (in accord with theoretical predictions by Link) between the intensity of the ozone bands and the distance from the center of the shadow. Since the ozone bands originate in the earth's atmosphere, this indicates that future spectrophotometric studies of lunar eclipses may yield new information on the earth's upper atmosphere.

CORRECTION

G. M. Reavis, of Fresno, Cal., writes: "On page 9 of the December issue there is an article about Prof. Zeeman and his death at the age of 78, and that he discovered the Zeeman effect in 1869. Now this was 74 years ago, so evidently the professor was only 4 at the time. This seems to beat the Quiz Kids, doesn't it? Perhaps you will give us the right dope in the next issue."

The "right dope" is that a simple transposition brings the correct date for Zeeman's discovery to 1896, making him 31 at the time — obviously, no Quiz Kid. —ED.

FRANK SCHLESINGER MEMORIAL SERVICES

About 200 friends and colleagues in the university, astronomers connected with other institutions, and former pupils, attended memorial exercises on November 19, 1943, in honor of Dr. Frank Schlesinger, professor of astronomy and director of Yale University Observatory, emeritus, who died on July 10th.

The exercises, held at Yale University, were presided over by its president. President Emeritus James Rowland Angell discussed in particular Dr. Schlesinger's relations to the institution, and the history and accomplishments of the observatory under Dr. Schlesinger.

Prof. Henry Norris Russell, of Princeton University, paid tribute to the late director's astronomical work. He emphasized the originality of Schlesinger's contributions to photographic astrometry, and the sound judgment he displayed in all his research.

Twenty-five astronomers from other institutions were present. These included Dr. Keivin Burns, who was sent by the University of Pittsburgh to represent that institution, and Col. F. J. M. Stratton, of the University of Cambridge, England, who was by good fortune sufficiently near New Haven that week to attend.

A gathering in the style of the Neighbors' Meetings followed the ceremonies, many of the astronomers remaining overnight to participate. These meetings were inaugurated by Prof. Schlesinger soon after he first came to Yale, and a great number of them had been held under his leadership.

A NEW COMET VAN GENT

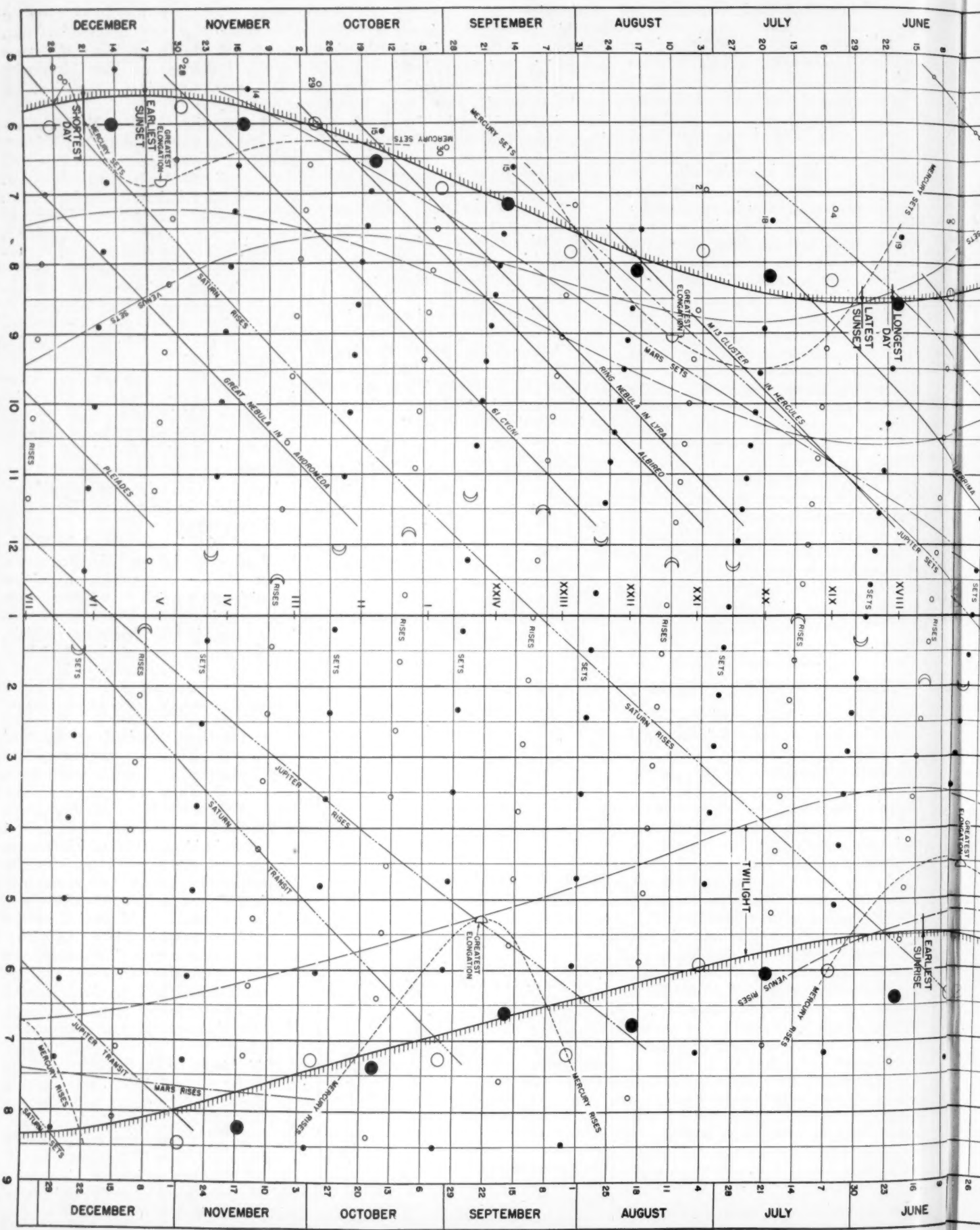
In a message received at Harvard on December 1st, news was conveyed of the discovery of a diffuse 9th-magnitude comet by the Dutch astronomer, H. van Gent, of the staff of the Union Observatory, Johannesburg, South Africa. By a strange coincidence, but which has no significance, the comet's position on November 27th was at $8^h\ 7^m$, $-34°\ 14'$, within a degree of Nova Puppis.

The extremely rapid motion of the new visitor carried it quickly away from that spot, at a rate which the message gave as $8^m\ 6^s$ to the west and $1\frac{1}{2}°$ to the south daily. This southerly motion practically precluded its early observation by observers in north temperate latitudes.

Added in press: On December 3rd, H. L. Giclas succeeded in photographing the new comet with the 13-inch telescope at Lowell Observatory, Flagstaff, Ariz. He reported the position on December 3.43554, 1943, as at $6^h\ 54^m\ 19^s.7$, $-44°\ 38'\ 46''$ (1943 co-ordinates). Thus, its rapid southerly and westerly motion was being maintained.

Graphic Time Table of

PREPARED BY THE MARYLAND



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of the Heavens - - 1944

YLAND ACADEMY OF SCIENCES

The Graphic Time Table of the Heavens

while still available may be secured without charge directly from the Maryland Academy of Sciences, 2724 N. Charles Street, Baltimore 18, Md. Blueprints of the original drawing before reproduction are available at cost—about 50 cents—size 40 x 27 inches.

The Graphic Time Table gives the rising and setting times of the sun, moon, and bright planets; the beginning of morning twilight and the ending of evening twilight; the times when certain stars and other objects of particular interest cross the meridian (that imaginary line which splits the sky into its eastern and western halves); the phases of the moon, and other interesting astronomical information. To illustrate by an example: The events of the night of January 6th may be found by following the horizontal line for that date across the page from left to right. We find that the sun sets at 4:49 p.m. standard time (5:49 war time); Mercury sets at 5:12 p.m. standard time; evening twilight ends at 6:27. Jupiter rises at 8:06; the Pleiades cross the meridian at 8:35; the planet Saturn transits at 10:18; followed by the Great Nebula in Orion at 10:30; and Jupiter at 2:52 a.m. Venus rises at 4:14; Mars sets at 4:32; the moon sets at 4:44; and Saturn, at 5:39. Morning twilight begins at 5:45 a.m.; with sunrise occurring at 7:22.

The dashes on the sunrise and sunset curves are for interpolation on days other than those indicated. Standard time is shown on the top line, and war time at the bottom. Sidereal time at midnight is shown by the Roman numerals down the standard-time midnight line.

The phases of the moon are indicated by the conventional symbols. Small black circles show moonset for the first half of the lunar month, and the small open circles show moonrise from full to new moon.

The small circles on the Jupiter transit curve indicate the nights on which occultations or eclipses of Jupiter's moons take place between the hours of seven and ten in the evening, Eastern standard time.

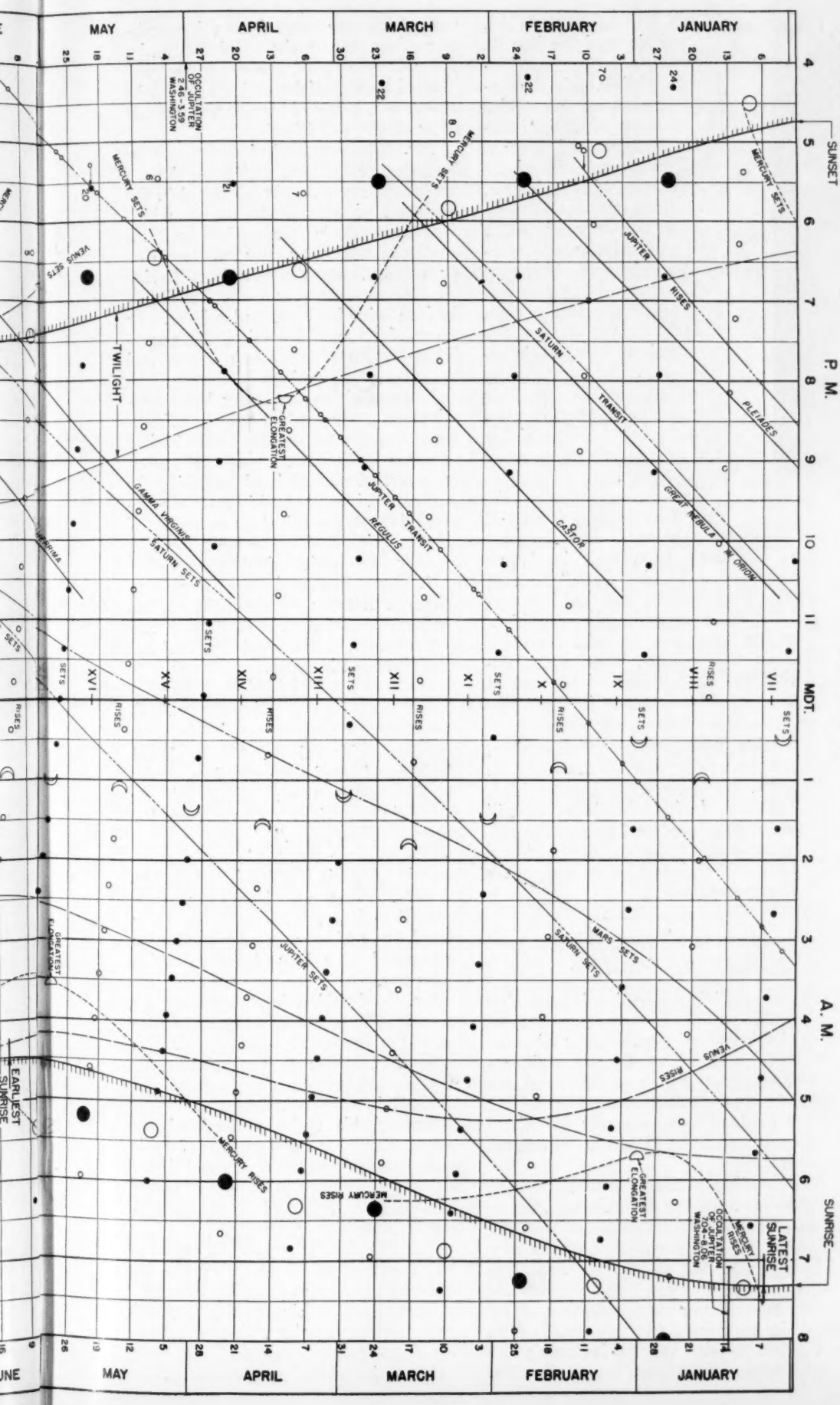
How to Correct for Your Position

As in all almanacs, times of rising and setting of sun, moon, and planets, are absolutely correct for only one point on the earth's surface—for this chart, latitude 40° north and longitude 90° west. However, the observer may easily correct for his own position. Correction for difference in latitude is comparatively minor—it need only be remembered that when members of the solar system are north of the equator, they remain visible longer as we go farther north, and for lesser time as we go farther south.

Correction for the difference in longitude depends only upon the observer's distance east or west of his standard time meridian (which is always an even multiple of 15). Some corrections are tabulated here:

Atlanta	+32	Detroit	+32
Baltimore	+28	Helena	+28
Boston	+22	Houston	+22
Chicago	−7	Los Angeles	−7
Cincinnati	+13	Minneapolis	+13
Denver	0	New Orleans	0
New York	−4		
Philadelphia	+1		
Pittsburgh	+20		
San Fr'cisco	+10		
St. Louis	+1		
Washington	+8		

All places with plus correction are west of the standard meridian, and the events will occur later. The usual correction of one hour for each standard time zone must also be made to times of eclipses of the moon and transits of Jupiter's satellites, and in the Far West slight corrections must be made to times of moonrise and moonset. For times of occultations and solar eclipses, refer to the "American Ephemeris."



Amateur Astronomers

EXHIBITION OF STEPHENS PAINTINGS

D. Owen Stephens

THE ASTRONOMICAL paintings of the late D. Owen Stephens were exhibited in Philadelphia the latter part of November, under the auspices of the Rittenhouse Astronomical Society. Held in the galleries of the Free Library of Philadelphia, the exhibit attracted the attention not only of people who are fundamentally interested in the fields of science and art, but large numbers of the general public as well. Schools throughout the city arranged to bring their astronomy clubs to view the paintings, and a number devoted some time in class prior to their trips explaining the significance of some of the canvases.

Special interest was displayed in the most famous of the Stephens paintings, "The Astronomer," pictured here, and in "Nine Planets and a Million Suns," both of which were lent by the Buhl Planetarium, Pittsburgh, for the exhibition. Canvases were also brought from the Hayden Planetarium, New York, depicting the 1937 eclipse of the sun as painted by Mr. Stephens in Peru. It was on his way home from this expedition that the artist died suddenly. Formal opening of the exhibition was marked by a special meeting of the Rittenhouse in honor of his widow and some of her husband's friends.

Mr. Stephens studied astronomy at Swarthmore College, and painted as a hobby. He was deeply interested in the portrayal of natural phenomena which frequently elude the artist, and his studies of eclipses or trees, constellations or nebulae, are recognized as having been the product of one who was deeply in love with both art and science. In many of his works, he develops a symbolism which adds to their beauty and significance as paintings.

The exhibition was hung by a committee of representatives of the Rittenhouse society and by others who wished to share in the event. Several volunteers carried a schedule of describing the pictures to interested visitors whose appreciation of the paintings as works of art was heightened by an understanding of their astronomical significance.

D. Owen Stephens' works have been shown a number of times in various local communities, and they have frequently been reproduced in national magazines and in books.

ARMAND N. SPITZ
Rittenhouse A. S.

THIS MONTH'S LECTURES

New York City: On January 5th, Hugh S. Rice, associate in astronomy of the American Museum of Natural History, will address the Amateur Astronomers Association on the subject, "The Nautical Almanac." This meeting is open to the public, and is held in the museum at 8:00 p.m. Before the meeting, members and their friends will have a Dutch-treat dinner at the Hotel Alden, Central Park West at 82nd Street, 6:00 p.m. On January 19th, the regular monthly observation meeting will be held under the guidance of Miss Hazel Boyd.

Cincinnati: "The Commercial Production of Optical Surfaces" is the title of a lecture by Nicholas Paul Miceli, superintendent of operations at the Panocular Company, before the Cincinnati Astronomical Association on January 14th. The meeting will be held at the University of Cincinnati Observatory at 8:00 p.m. A short business session for the purpose of electing officers for 1944 will conclude the meeting.

Cleveland: The Cleveland Astronomical Society, at its meeting of January 14th, will hear Dr. O. C. Mohler, of the McMath-Hulbert Observatory, speak on "The Sun's Eruptive Prominences." This meeting will be held at 8:00 p.m., at the Warner and Swasey Observatory, East Cleveland.

Philadelphia: The annual meeting of the Rittenhouse Astronomical Society will be held at The Franklin Institute on January 14th, at 8:00 p.m. Induction of new officers will take place, and the retiring president, Armand N. Spitz, will give an address entitled, "What's Up." His discussion will cover what man knows about the outermost reaches of our planet, and how he knows it without being able to make direct observations.

DAWSON RECEIVES NOVA MEDAL

IN A DISPATCH dated September 16th, from the United States embassy in Argentina to the secretary of state, a report is given of the ceremonies attendant upon the presentation of the David B. Pickering nova medal to Dr. Bernhard H. Dawson, for his visual discovery of Nova Puppis in November, 1942.

According to the dispatch, the ceremony took place at five o'clock on Saturday, September 11th, before an audience which filled the main hall of the new building of the Asociación Argentina "Amigos de la Astronomía," opened for the first time on this occasion. The president of the Asociación, Sr. José R. Naveira, spoke briefly, indicating the significance of the honor bestowed on Dr. Dawson. Edward L. Reed, chargé d'affaires *ad interim,* presented the medal to Dr. Dawson on behalf of the A.A.V.S.O., and Dr. Dawson read a paper on "New Stars."

The audience was made up of members of the Asociación and friends of Dr. Dawson. From the embassy, Mr. Hugh Millard and Dr. H. Keniston were in attendance and Mr. Henry E. Ewing represented the local co-ordination committee.

Mr. Reed said, when presenting the medal: "The presentation to Dr. Dawson has a special significance, for Dr. Dawson is, in the most complete sense of the word, an American. Born and educated in the United States, he has consecrated his entire professional career to Argentine institutions, and he is an Argentine citizen. North and South may thus share their pride at the honour that has been conferred on this distinguished American scientist.

"On this day, in which America recalls the life and death of the great Argentine, Domingo Faustino Sarmiento, we can justly celebrate this new proof of the intellectual ties which bind both countries. In them we find the most solid base for mutual understanding."

BEGINNER'S PAGE

Man and His Expanding Universe — II

By Percy W. Witherell

THE ANCIENT Egyptians explained the daily appearance, motion, and disappearance of the sun, moon, planets, and stars, by supposing them to travel in boats across the firmament; to die when they set in the west; and, after passing through Amenti, the "abode of the dead" in the underworld, to be reborn when they reappeared in the east.

Geb, the earth, was the husband of Nut, the sky. The sun gods and goddesses were their children. Sometimes Nut is represented by two female figures, a large one bent over a smaller, with their fingers and toes touching the opposite horizons. This symbolized the different paths of the stars at the equator, which set, and those near the pole, that never dipped below the horizon.

We have noted that the beginning of the Egyptian sacred year was at the summer solstice because this coincided with the time of the overflowing of the Nile, on which event depended the feeding of the nation.

In contrast, the Tigris and Euphrates overflow at the vernal equinox, and the Babylonian calendar used this solar event to fix the start of the new year.

The Temple of Heaven in Peiping was oriented to observe the winter solstice at a national ceremony in which the Emperor of China made humble acknowledgement to the supreme being. At Stonehenge in England, the rising sun at the summer solstice threw its rays on the stone altar of the Druids. In many parts of the European continent the ruins of similar, massive stone monuments indicate a similar use.

Joseph wrote that the temple of Solomon was open at the eastern end and so oriented that the rays of the rising sun at the spring and autumn equinoxes penetrated to the holy of holies and were reflected by the jewels of the high priest. The basilica of St. Peter's at Rome is placed due east and west so that the rays of the rising sun at the vernal equinox can pass through the open outer and inner doors and illuminate the high altar at the end of the nave.

Early historical events were recorded as in some year of the reign of the presiding sovereign. Today, our official government proclamations are given as in the —— year of the Independence of the United States of America, in addition to that of Anno Domini. As in the recent past certain given names are popular in a family, so the early dynasties repeated certain names over so many centuries or even milleniums that any correlation with our modern calendar would seem almost hopeless.

Fortunately, astronomy is able to clarify the situation. Striking celestial phenomena were thought to be good or bad omens in the life of the monarch, and were recorded with considerable accuracy. Modern calculations can often show the time these events must have occurred, and if the particular event can be identified within a reasonable period, the exact day and year can be determined. This is self-evident.

Another less well-known but equally important combination of circumstances has helped to clear some of the fog overlaying the past. In all ages, important people have erected buildings as memorials. As the modern man builds libraries or colleges, or endows foundations, the ancient monarch built tombs and temples. The practical, learned men of the time arranged the plans of such buildings so that they would have a utilitarian value in addition to the builder's satisfaction in an imposing memorial.

Naturally, such buildings were oriented to observe the rising, setting, or meridian passage of the celestial body that was in use for determining time in that particular era.

When a new sovereign ascended the throne, he sometimes believed in a religion different from his predecessor and immediately began the erection of a temple or an extension of an existing one to exemplify his belief. If this involved the observing of a star instead of the sun or some such radical change, the date of the erection of such a building can be determined. To fulfill the requirements of its intended use for observation it must have been built within a certain epoch. So the records of the king can be correlated with the modern calendar.

NOTICE

EFFECTIVE with new subscriptions ordered after March 1st, and with renewals ordered after April 1st, the price of **Sky and Telescope** is increased to $2.50 per year for the United States and possessions, including service men and women overseas; to $3.00 per year for Canada and countries in the Pan-American postal union; and to $3.50 per year for all other foreign countries. On March 1st, the single copy sales price will be 25 cents.

Current subscriptions expiring with the issue of March, 1944, and thereafter, will be billed at the new rates, but may be renewed at present rates until April 1st. All current subscriptions may be extended for any period at present rates before that date.

SKY PUBLISHING CORPORATION

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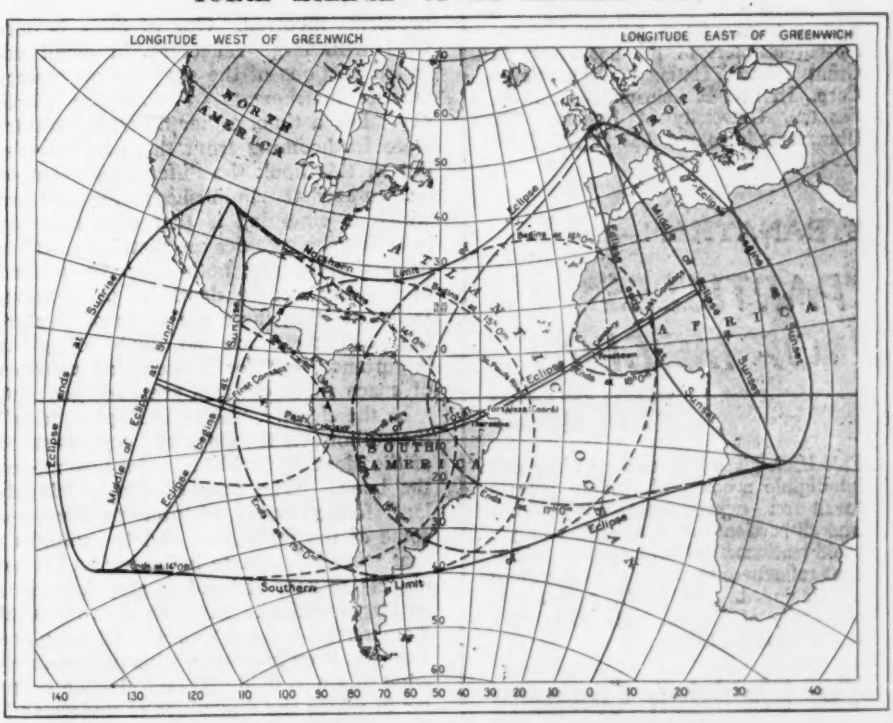

This chart, reproduced from the American Ephemeris and Nautical Almanac, shows that the eclipse will appear as partial in the southern United States. The hours of beginning and ending are in Universal or Greenwich civil time. A note on the times of partial eclipse at various points in the Caribbean region will be found on page 22. For a more complete account of the total phase and charts of its path across South America, see "Sky and Telescope," October, 1943, pages 12 and 13.

Blakiston Books

SHAPLEY—

GALAXIES

This, the latest volume in the HARVARD BOOKS ON ASTRONOMY series is based upon extensive original information concerning stars, star clusters, and those distant external systems that resemble our own Milky Way Galaxy. The explorations described cover distances of some hundreds of millions of light-years now reached by the greatest photographic telescopes. The book is richly illustrated with most unusual photographs. By Harlow Shapley, Harvard College Observatory. 126 Illus. 229 Pages. $2.50 (1943)

HECTOR, LEIN and SCOUTEN—

ELECTRONIC PHYSICS

This book presents a clear, intelligible account of the principles of electronic physics. Electrical phenomena are studied from the electron-proton point of view. Even magnetism is described in terms of moving electric charges. The electrical nature of atoms of all elements is constantly used throughout the text in the explanations, thus preparing the reader to follow promptly the phenomena of radio-activity and modern transmutation presented in the closing chapters of the book. By L. Grant Hector, National Union Radio Corp., Herbert S. Lein and Clifford E. Scouten, University of Buffalo. 289 Illus., most in colors. 355 Pages. $3.75 (1943)

STRANATHAN—

"PARTICLES" OF MODERN PHYSICS

This book gives the reader a clear and intelligible account of modern physics based on experimental observations. The discussions are thorough and yet avoid mathematical involvement. Abundant references to the original literature are included. By J. D. Stranathan, University of Kansas. 211 Illus. 571 Pages. $4.00 (1942)

The Blakiston Company

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Philadelphia 5, Pa.

BOOKS AND THE SKY

GALAXIES

Harlow Shapley. The Blakiston Company, Philadelphia, 1943. 229 pages. $2.50.

IN THE 229 pages of this newest volume of the Harvard books on astronomy the author has put the results of more than 20 years of his researches. Dr. Shapley was the first to realize what a tremendous tool was available with Miss Leavitt's discovery of relations between periods and apparent magnitudes of the variable stars in the Small Magellanic Cloud; he seems to have been the first to state that the velocities of the spirals appeared to be greater for the fainter objects, thus leading to the belief that there must be a connection between distance and velocity. His own contributions in this field have been of inestimable importance, and it is a very fine story of his own work and that of his co-workers and colleagues at other observatories that he has told in this book.

The author warns us that in the book there will be little contact with mundane affairs, yet he cautions us not to forget that we receive our messages from distant galaxies in the form of light waves, and anything that increases our knowledge of the nature and behavior of light is of some practical value. But it is hardly necessary for him to apologize for what I firmly believe to be man's most noble and daring aspiration: to understand the organization of the whole of creation.

Those who have followed the research papers in this field will have appreciated that there are two very different approaches to the solution of the broad problems involved. One of these is pursued with large reflectors, in small selected portions of the sky; the other uses smaller instruments to cover the whole sky. For a time, rather divergent results were forthcoming from the two surveys, but in this book the differences seem to be somewhat diminished; the picture which is emerging is that of a universe in which the galaxies are distributed more or less uniformly, both over the surface of the sky and in depth of penetration. It is true that there are areas of clustering, and these are no doubt of great importance, but for tremendous volumes of space these clusters are averaged out.

In the chapter, "Galactic Explorations," the author sets the stage and collects some of the ideas that will be useful throughout the book. "The Star Clouds of Magellan" follows as a chapter to illustrate some of the techniques and to remind us that we are fortunate in having had these objects so near at hand as steppingstones to larger realms. In "The Astronomical Toolhouse," we get to see how ingenious man has been in adapting his prior knowledge to a new field. Then follows a chapter in which the difficulties of understanding our Milky Way system are fairly put, and again we gather material for carrying our ideas farther into space as we explore "The Neighboring Galaxies." Again we are fortunate in having sample galaxies near enough for detailed analysis, before passing on to the rest of the observable universe, "The Metagalaxy." In the closing chapter, "The Expanding Universe," the behavior of the visible cosmos is described from the viewpoint of observation, and some discussion of possible interpretations is set down.

It is in the matters of observational technique and summary of findings, as well as in suggestion of what we shall later think of our findings, that the author impresses me most. He speculates with a thought to the pitfalls which have sometimes in the past misled us, and displays a happy mixture of caution and surmise.

By an interesting paradox, this grandest of all problems requires less background and less concentration for its appreciation than some others of narrower import. It has been my conviction for many years that if there is one aspect of the work of the astronomer which must be understood by the non-astronomical member of the intelligent public, this is it. It is unfortunate that those we insist upon calling "laymen" always worry about such relatively trivial matters as possible life on Mars or the coming of a great comet.

In this beautifully illustrated volume, Dr. Shapley has put down, in his breezy and lucid style, just what is good for these readers. He treats very fairly the ideas of his "opponents," and has even given ground a little, here and there. I am quite sure, too, that professional astronomers will recognize in the book an interim report which clears up many a confused matter and provides a point of departure for the further technical literature in this field. It is a most worthy member of the very remarkable series of books.

ROY K. MARSHALL
Fels Planetarium

THE STAR FINDER

Henry M. Neely. Smith and Durrell, Inc., New York, 1943. 46 pages and charts. $2.75.

THIS isn't a book that teaches you only how to find stars; it is a snappily written and neatly illustrated volume in short-story form, covering some problems relating to astronomy, parallax, celestial navigation, and wonders of the sky. These subjects are woven together, by word and pictures, in easily understandable terms. And still it is not a primer.

Millions of people have never seen a gyroscope. The author clearly shows that we are living on one, and then proceeds to make comparisons which prove the value of this remarkable instrument. You are taken on a trip around the great inverted globe under which we live, and by simple rules quickly shown in a way you can't forget how the clocks and watches we use every day are linked with sidereal time. A conductor cries, "All aboard," and away you go on a star-train that starts from Greenwich, England, and keeps to a schedule that is never late!

You will recall how your geometry teacher always insisted that parallel lines never meet. Well, just read the chapter on star parallax and discover a new angle

of approach to the explanation of this intriguing subject.

A trip to the north pole presents new sidelights in discovering your geographical position on earth. By the use of plumb lines, and graphically drawn hour circles, your local hour angle is picked up in astonishingly few calculations; and you are thus led by unbelievable (until you read them) short cuts through the practical problems of celestial navigation. In a leisurely way you have learned new and better means of determining, by the stars, right ascension and declination, latitude and longitude, Greenwich hour angle, local hour angle, and equation of time.

As must be so in a book of this kind, if complications are to be avoided, the exceptions to some "rules" are not always explained or given. The author does not claim to be an astronomer; in fact, the uniqueness of his presentation (and much of its value) is a result of his not being one. The few slight errors need not be described, but the impression that the "day half of the sky" is that part below the observer's horizon should be corrected. This error appears in the diagram facing page 8 (where the sun is apparently shining from about 40° south latitude), also in drawing B facing page 10, and in a further reference to it on page 12.

In the last pages of the book you follow the celestial equator across the sky, and step by step become familiar with the movements of the planets, and the position of navigational stars. And lastly, the book contains some large black-and-white constellation charts that are quite useful. The illustrations throughout the volume are worthy of favorable comment.

FRED M. GARLAND
A.A.A. of Pittsburgh

A START IN METEOROLOGY

Armand N. Spitz. Norman W. Henley Publishing Company, New York, 1943. Second revised edition, 97 pages. $1.50.

THIS revised edition of a readable little text has just appeared; it is a definite improvement on the first edition in so far as the general appearance is concerned. Larger and improved loose maps will make it much easier for the reader to practice the preparation of weather maps.

The text itself still remains excellent and has undergone only a few minor changes. A few good cloud photographs, to take the place of the sketches of clouds, would stimulate the interest of the eager reader.

The author has covered, in a clear and precise manner, in his chapters on "Winds, Why, Where and How," "Air in Masses," and "The Front Edge of an Air Mass," the fundamentals of elementary meteorology. A careful reading of these chapters will fix the movement and actions of air firmly in the reader's mind. The chapters on "The Weather Man's Tools," "Climate and Weather," and "Heat and Motion," help to complete the picture.

As a well-rounded introduction to the science of meteorology, this book should prove invaluable to students of high school age who wish to set up their own weather stations.

JOHN BOK

Sauce for the Gander

READERS are asked to send in questions, from which this editor will select the best each month to answer here. The following question comes from Pvt. Woodrow Smallwood, Camp Crowder, Mo.

Q. Is magnetism confined to the earth alone or is it universal?

A. There is no reason to believe that any type of phenomenon is restricted to the earth. In the case of magnetism in particular, its existence elsewhere is evident directly from the effect of a magnetic field on the polarization of light. It is possible thus to chart magnetic fields due to sunspots on the sun. Consider the matter from general physical principles: every moving electric charge is surrounded by a magnetic field; matter is largely, if not exclusively, composed of electrical charges; hence magnetic fields must surround matter everywhere. Where temperatures are high, as in the stars, electrons become freed from the atoms to which they are usually attached, and magnetic phenomena must in consequence be much more intense in the sun and stars than they are on the earth. This does not, of course, refer to the magnetism which results from the orientation of molecules in a solid: such magnetism is restricted to the lower temperatures wherein matter may exist in the solid state.

Mr. Hubert Swoboda, of Green Bay, Wis., writes: "I must thank you for answering my question in the August issue. Here is one more little problem which I am submitting for your column."

Q. When a star is seen near the surface of the sun at a solar eclipse the star is apparently shifted outward from its normal position. This outward displacement of the star is caused by the gravitational field of the sun — according to relativity. But why doesn't the atmosphere of the sun cause this phenomenon, by refracting the light rays from the star, in a manner similar to the refraction of light by our own atmosphere?

A. There are several explanations available for the shift in the apparent position of a star. However, the problem is not to account for a shift, but a shift as large as the one actually observed. The sun does have an extensive atmosphere, although extremely tenuous, and this would produce some refraction, but apparently not enough to account for the observed phenomenon. This does not mean that the relativity explanation is the only one satisfactory on a quantitative basis: alternative explanations have been offered for all of the phenomena successfully predicted by Einstein. For one example, see Albert Eagle's "An Alternative Explanation of Relativity Phenomena," in the **London, Edinburgh and Dublin Philosophical Magazine,** Vol. XXVIII, 1939, page 694.

L. J. LAFLEUR
Antioch College
Yellow Springs, Ohio

NEW BOOKS RECEIVED

FOGS, CLOUDS AND AVIATION, *W. J. Humphreys*, 1943, *Williams and Wilkins*. 200 pages. $3.00.

An up-to-date version of the author's famous *Fogs and Clouds*, with timely application for the pilot, and including 93 spectacular cloud photographs.

NAVIGATION, *Kells, Kern,* and *Bland*, 1943, *McGraw-Hill*. 479 pages. $5.00.

A complete course in navigation, covering the necessary mathematics and equipment, piloting, celestial navigation, star identification, with graded sets of exercises, and answers to problems.

THE CALENDAR FOR EVERYBODY, *Elisabeth Achelis*, 1943, *Putnam's*. 141 pages. $1.50.

A review of past and present calendars, and calendar reform, leading up to a discussion of the World calendar and ways and means for its adoption. The author is president of the World Calendar Association.

THE "PARTICLES" OF MODERN PHYSICS, *J. D. Stranathan*, 1942, *Blakiston*. 571 pages. $4.00.

A survey text in modern physics, built around the "particles" — electrons, positrons, photons, X-rays, cosmic rays, and others, with separate problems and answers.

KNOWING THE WEATHER, *T. Morris Longstreth*, 1943, *Macmillan*. 150 pages. $1.69.

This is a weather book written in the popular manner, and it especially stresses the relation of weather to modern living and future travel.

LEARNING TO NAVIGATE, *Weems* and *Eberle*, 1943, *Pitman*. 135 pages. $2.00.

New edition, revised and enlarged, of a simple, short text in navigation.

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THE BOOK CORNER

Hayden Planetarium - New York City

AMATEUR ASTRONOMERS

who make their own telescopes soon find that much of the fun of the hobby is in planning and building the mounting; grinding, polishing, and accurately shaping the glass parts by hand — all at a low cost. With inexpensive glass, abrasives, and pitch, and with the help of the practical, detailed instructions in

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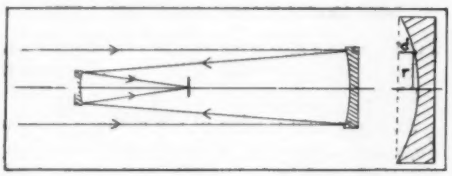
GLEANINGS FOR A. T. M.s

The Schwarzschild Telescope

AS HAS been previously mentioned in these columns, the general solution to the problem of a telescope composed of two mirrors and which shall be free of spherical aberration, curvature of the field, and astigmatism, yields an impracticable result — an instrument with convex primary and convex secondary, and a virtual image; but if the conditions are relaxed the equations lead to expressions for several types of telescopes. One of these is the now well-known Schmidt camera, another the so-called "short" telescopes (see **A.T.M.A.**); and the camera designed by James G. Baker, described in The SKY, December, 1940, is another derivative of the same general equations.

Another derivative, developed by the man who originally found the solution of the general problem, is the Schwarzschild telescope, which may be of interest to certain experimental amateurs. Dr. Charles H. Smiley, of Ladd Observatory, Brown University, Providence, R. I., issued the following discussion of the instrument, which we reprint here with his permission:

"In 1905, Karl Schwarzschild, a German astronomer, found that by using two mirrors, each appropriately figured, one could greatly increase the useful field and speed of a reflector. The primary mirror was approximately hyperboloidal; the secondary, half as great in diameter, was approximately ellipsoidal in shape. This telescope could be built as an f/3.5 to



cover a field 3 degrees in diameter or as an f/1.2 to cover a field 1.5 degrees in diameter. It had two disadvantages — one was that the telescope tube had to be rather long, the other that the secondary mirror cut off one fourth of the light which would otherwise reach the primary. On the other hand, star images given by this telescope were round, even near the edge of the field, and the focal surface was flat so ordinary photographic plates could be used in it.

"In 1923, G. W. Ritchey started to make a Schwarzschild but put it aside without completing it. In 1917, Prof. W. A. Cogshall, of the University of Indiana, completed the mirrors for a Schwarzschild but the mounting was not completed until 1937. Other Schwarzschilds are now under construction (1940) including one of 12 inches aperture and 36 inches focal length being made by Mr. Arthur A. Hoag, of Ladd Observatory, Brown University.

Numerical Data for a Schwarzschild Telescope:

Nominal focal ratio	f/3
Focal length	36″
Secondary to plate	18″
Effective focal ratio	f/3.5
Separation of mirrors	45″

Primary mirror:

Approximately hyperboloidal	
Diameter	12″
Radius of curvature	180″

Secondary mirror:

Approximately ellipsoidal	
Diameter	6″
Radius of curvature	60″
Both mirrors concave	

Surface dimensions:

	Distance from center, r	Depth d
Primary mirror	0″	.0997″
	1″	.0969″
	2″	.0886″
	3″	.0747″
	4″	.0553″
	5″	.0304″
	6″	.0000″
Secondary mirror	0″	.0752″
	½″	.0731″
	1″	.0669″
	1½″	.0564″
	2″	.0418″
	2½″	.0230″
	3″	.0000″

Equation: $y = .75 - .1x^2 + .0125x^4$;
$y = -.5 + .3x^2 + .12x^4$,

where x and y are measured in units of

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the focal length of the completed camera."

The above dimensions could, of course, be scaled proportionately for any aperture desired.

We have not given any thought to methods of construction of the optical elements of the Schwarzschild telescope. If any readers have had experience with such an instrument, or have any ideas concerning methods of figuring and testing, we should appreciate hearing from them, with a view to publishing their contributions.

In Focus

LAST month's picture of lunar craters, together with the letter from Julio C. Ortiz regarding the apparent inversion sometimes observed in such photographs, created interest revealed by several letters we have received on the subject. By a strange coincidence, in **Time** for November 22nd, the same matter is discussed in a letter from Lt. Leonard C. Briggs, Infantry School, Fort Benning, Ga., but his reference is to an Army photograph of the bomb craters at the Focke-Wulf plant in Germany.

Except for the consideration that south is usually at the top in telescopic views, little care is usually given as to whether or not astronomical photographs are printed "upside-down." We like to remind ourselves that out in space there is no top or bottom, and one might think that in an aerial photograph the same was true, but examination of the bomb-crater photograph shows that this is not so. Lt. Briggs recommends to **Time** editors that "shadows stab stomachs," and perhaps the same rule ought to be applied to the orientation of lunar crater pictures to avoid such inversion. There is, however, the perhaps more important rule which Lt. Briggs gives, that the picture be viewed between the observer and the source of light, for by placing pictures beyond the light the inversion sometimes disappears even if the shadows are oriented improperly.

Richard N. Berry, of Plainfield, N. J., writes: "Possibly the reason is that man, being an earth-bound creature on the average, is accustomed to seeing shadows mostly when he faces the source of light (usually the sun), the shadows then being cast toward him. When the source is behind and above the observer, the shadows are hidden by the objects which cast them. Thus the brain automatically interprets shadows as indicating the source of light to be opposite the observer. . . .

"While this may help to account for the phenomenon as observed in light and shadow, it does not explain the same effect in line diagrams. So inversion in photographs is no doubt complicated by the latter effect for which I have heard no explanation."

From James H. Johnson, U. S. Coast Guard, we hear: "Amateur astronomers have long experienced the optical illusion which Mr. Ortiz calls a phenomenon. There is nothing unusual nor remarkable to have an inversion of relief appear, especially upon viewing pictures or drawings of the lunar landscape, than to have several parallel lines appear not so in one of the many tricks presenting optical illusions." Mr. Johnson refers to the **Time** photograph, which Mr. Berry had also mentioned.

Miss Eliza M. Chatfield, of Seymour, Conn., expresses our own experiences rather closely, when she writes:

"Well, that moon picture on the back lid of the December **Sky and Telescope**, 'ain't that sumpin!' The magazine lay on my table two days after it came and the moon had no craters, but round mesas with a hole in the center of each, resembling those little tin squeakers that used to be in children's rubber toys and always came out and had to be franticly searched for since everyone was sure the baby had swallowed it. Near the right-hand edge were round mounds cut straight across with shadow and almost in equal parts.

"I took the magazine to bed one evening and read the article 'In Focus' and then I tried to make the picture invert by various means but nothing doing. Finally, I pushed it aside and started to get out of bed to finish my evening stunts when I looked at the picture and there before me lay the old familiar moon with its craters and depressions and great plains spreading all about. Since then I have tried it in every light and position and no law of optical illusion holds good, but only shows that the exception proves the rule.

"When they choose to hide and masquerade as mesas, they do so, and as I sit here and write with the picture before me it has changed back and forth several times, sometimes when I look away and sometimes while I am looking right at it. As it lies on the table, sometimes when I enter the room I see mesas, sometimes craters, regardless of the light or how it is falling. I have shown it to several people and all have the same experience.

"Does anyone ever have such an experience looking through a refractor at the moon? I belong to the New Haven A. A. S., and sometimes view the splendors of the heavens through the Reed 9-inch at Yale University Observatory."

Oliver C. Collins, of the University of Nebraska, believes the **Time** note gives support to the explanation by Mr. Ortiz.

Another lunar landscape from the Lick album forms our back cover this month and presents further opportunity to check on your own inversion theory.

Archimedes is the large ring plain just below the center of the picture; it is 50 miles in diameter. To its right, in Mare Imbrium, is Timocharis, with a craterlet on the summit of its central mountain. In the upper right corner is Eratosthenes, its walls over 10,000 feet high; it is at the extremity of the lunar Apennines, which contain peaks from 12,000 to 20,000 feet in height. Autolycus and its larger companion crater, Aristillus, are to the left of Archimedes, their floors in shadow. The sharp, isolated mountain below Aristillus, casting such an interesting shadow, is Piton. On the lower left edge of the picture is the ring plain Cassini, containing a large interior crater and several imperfect rings.

THE INDEX FOR VOLUME II

is on the press. It will be similar to that for Volume I, including title page, author, title, subject, and topic references. The index adds considerably to the usefulness of the year's issues. Send 25c and we shall mail your copy as soon as it is off the press.

The Index for Volume I is still available, as are a limited number of copies of the magazine itself. Some bound sets of Volume I, including index, are available for $5.00 each, postpaid.

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Classified advertisements are accepted for this column at 30c a line per insertion, 7 words to the line. Minimum ad 3 lines. Remittance must accompany orders. Address Ad Dept., Sky and Telescope, Harvard College Observatory, Cambridge 38, Mass.

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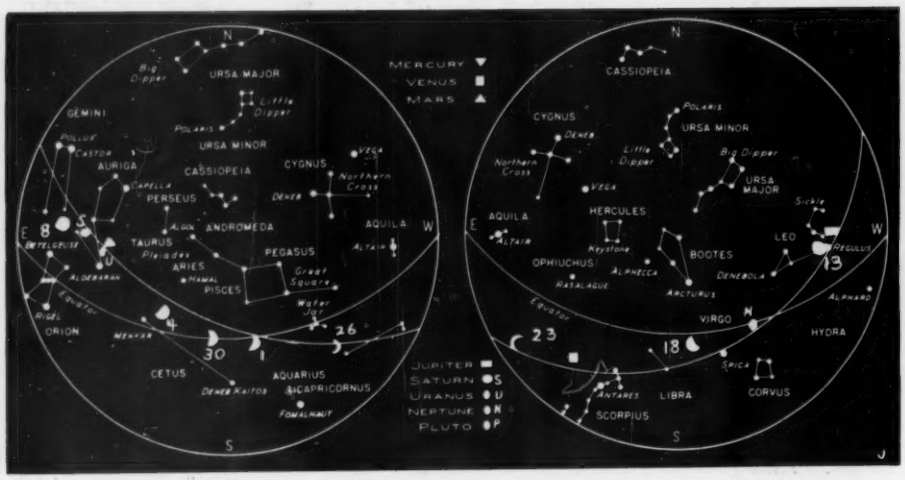
HERE AND THERE WITH AMATEURS

This is not intended as a complete list of societies, but rather to serve as a guide for persons near these centers, and to provide information for transplanted amateurs who may wish to visit other groups.

City	*Organization*	*Date*	*P.M.*	*Season*	*Meeting Place*	*Communicate with*
BOSTON	BOND AST. CLUB	1st Thu.	8:15	Oct.-June	Harvard Obs.	Homer D. Ricker, Harvard Observatory
"	A.T.M.S OF BOSTON	2nd Thu.	8:15	Sept.-June	Harvard Obs.	C. S. Cook, 16 Belfry Terr., Lexington
BROOKLYN, N. Y.	AST. DEPT., B'KLYN INST.	Rd. Table 3rd Thu.	8:00	Oct.-April	Brooklyn Inst.	William Henry, 154 Nassau St., N. Y. C., *BA.* 7-9473
BUFFALO	A.T.M.S & OBSERVERS	1st, 3rd Fri.	8:00	Oct.-June	Mus. of Science	J. J. Davis, Museum of Science
CHATTANOOGA	BARNARD A. S.	4th Fri.	7:30	All year	Chattanooga Obs.	C. T. Jones, 1220 James Bldg., *CHat.* 6-8341
CHICAGO	BURNHAM A. S.	2nd, 4th Tue.	8:00	Sept.-June	La Salle Hotel	Miss W. Sawtell, 928 N. Harvey Ave.
CINCINNATI	CIN. A.A.	2nd Fri.	8:00	Sept.-June	Cincinnati Obs.	Dan McCarthy, 1622 DeSales Lane
CLEVELAND	CLEVELAND A. S.	Fri.	8:00	Sept.-June	Warner & Swasey Obs.	Mrs. Royce Parkin, The Cleveland Club
DAYTONA BEACH	D. B. STARGAZERS	Alt. Mon.	8:00	Nov.-June	500 S. Ridgewood Ave.	Rolland E. Stevens, 500 S. Ridgewood
DETROIT	DETROIT A. S.	2nd Sun.	3:00	Sept.-June	Wayne U., Rm. 187	E. R. Phelps, Wayne University
"	NORTHWEST A.A.S.	1st, 3rd Tue.	8:00	Sept.-June	Redford High Sch.	A. J. Walrath, 14024 Archdale Ave.
DULUTH, MINN.	DULUTH AST. CLUB	Meetings suspended			Darling Obs.	W. S. Telford, 126 N. 33rd Ave. E.
FT. WORTH	TEX. OBSERVERS	No regular meetings				Oscar E. Monnig, 1010 Morningside Dr.
GADSDEN, ALA.	ALA. A.A.	1st Thu.	7:30	All year	Ala. Power Audit.	Brent L. Harrell, 1176 *W* or 55
INDIANAPOLIS	INDIANA A.A.	1st Sun.	2:00	All year	Central Library Audit.	E. W. Johnson, 808 Peoples Bank Bldg.
JOLIET, ILL.	JOLIET A.S.	Alt. Tue.	8:00	Oct.-May	Jol. Mus. & Art Gall'y	Mrs. Robert L. Price, 403 Second Ave.
LOS ANGELES	L.A.A.S.	2nd Thu.	8:15	.....	2606 W. 8th St.	Charles Ross, 2606 W. 8th St.
LOUISVILLE, KY.	L'VILLE A.S.	3rd Tue.	8:00	Sept.-May	Women's Bldg., Univ. of Louisville	Mary Eberhard, 3-102 Crescent Ct. *Taylor* 4157
MADISON, WIS.	MADISON A.S.	2nd Wed.	8:00	All year	Washburn Obs.	C. M. Huffer, Univ. of Wisconsin
MILWAUKEE	MILW. A.S.	1st Thu.	8:00	Oct.-May	Marquette U., Eng. Col.	E. A. Halbach, *Hopkins* 4748
MOLINE, ILL.	POP. AST. CLUB	2nd Wed.	7:30	Oct.-April	Sky Ridge Obs.	Carl H. Gamble, Route 1
NEW HAVEN	NEW HAVEN A.A.S.	4th Sat.	8:00	Sept.-June	Yale Obs.	J. J. Neale, 29 Fairmont Ave.
NEW ORLEANS	A.S. of N. ORLEANS	Last Wed.	8:00	Sept.-May	Cunningham Obs.	Dr. J. Adair Lyon, 1210 Broadway
NEW YORK	A.A.A.	1st, 3rd Wed.	8:15	Oct.-May	Amer. Mus. Nat. Hist.	G. V. Plachy, Hayden Plan., *EN.* 2-8500
" "	JUNIOR AST. CLUB	Alt. Sat.	8:00	Oct.-May	Amer. Mus. Nat. Hist.	J. B. Rothschild, Hayden Plan., *EN.* 2-8500
NORFOLK, VA.	A.A.S. OF NORFOLK	4th Tue.	8:00	All year	Central Y.M.C.A.	P. N. Anderson, 635 W. 29th St.
NORWALK, CONN.	NORWALK AST. SOC.	Last Fri.	8:00	Sept.-June	Private houses	Mrs. A. Hamilton, 4 Union Pk., 6-4297
OAKLAND, CAL.	EASTBAY A.A.	1st Sat.	8:00	Sept.-June	Chabot Obs.	Miss H. E. Neall, 6557 Whitney St.
PHILADELPHIA	A.A. OF F.I.	3rd Fri.	8:00	All year	The Franklin Inst.	Edwin F. Bailey, *Rit.* 3050
"	RITTENHOUSE A.S.	2nd Fri.	8:00	Oct.-May	The Franklin Inst.	A. C. Schock, *Rit.* 3050
PITTSBURGH	A.A.A. OF P'BURGH	2nd Fri.	8:00	Sept.-June	Buhl Planetarium	Louis E. Bier, 402 Cedarhurst
PONTIAC, MICH.	PONTIAC A.A.A.	2nd Mon.	8:00	All year	Private homes	John Setlow, Jr., 593 S. Paddock St.
PORTLAND, ME.	A.S. OF MAINE	2nd Fri.	8:00	All year	Private homes	H. M. Harris, 27 Victory Ave., S. Portland
PORTLAND, ORE.	AST. STUDY GROUP	1st Mon.	8:00	All year	420-3 Av., Rm. 212	H. J. Carruthers, 427 S. 61 Ave.
PROVIDENCE, R. I.	SKYSCRAPERS	1st Wed.	8:00	All year	Wilson Hall, Brown U.	Ladd Obs., Brown U., *GA.* 1633
READING, PA.	READING-BERKS A.C.	2nd Thu.	8:00	Sept.-June	Albright College	Mrs. F. P. Babb, 2708 Filbert Ave.
RENO, NEV.	A.S. OF NEV.	4th Wed.	.....	All year	Univ. of Nevada	G. B. Blair, University of Nevada
ROCHESTER, N. Y.	ROCH. AST. CLUB	Alt. Fri.	8:00	Oct.-May	Univ. of Rochester	M. L. Groff, 400 University Ave.
SAN ANTONIO	SAN ANT. A.A.	3rd Mon.	8:00	All year	Le Villela	R. B. Poage, 807 Hammond Ave.
SCHENECTADY	S'TADY AST. CLUB	3rd Mon.	8:00	All year	Observatory site	C. H. Chapman, 216 Glen Ave., Scotia
SOUTH BEND, IND.	ST. JOSEPH VAL. AST.	Last Tue.	8:00	All year	928 Oak St.	Fannie Mae Chupp, 224 Seebirt Pl.
STAMFORD, CONN.	STAMFORD AST. SOC.	4th Wed.	8:00	Oct.-June	Stamford Museum	Stamford Mus., 300 Main St.
TACOMA, WASH.	TACOMA A.A.	1st Mon.	.....	All year	Coll. of Puget Sound	Geo. Croston, *Gar.* 4124
TULSA, OKLA.	TULSA A.S.	2nd Tue.	.....	All year	Holland Hall	V. L. Jones, 4-8462
WASHINGTON, D.C.	NAT'L. CAP. A.A.A.	1st Sat.	8:00	Oct.-June	U. S. Nat'l. Museum	Miss D. Harris, 1621 T St., N.W., *Du.* 4200
WICHITA, KANS.	WICHITA A.S.	2nd Tue.	8:00	All year	E. High Sch., Rm. 214	S. S. Whitehead, 2322 E. Douglas, 33148
YAKIMA, WASH.	YAK. AM. ASTR'MERS	3rd Tue.	7:30	All year	Y.M.C.A. Lounge	C. A. Zumwalt, 1019 Pleasant

THE MOON AND PLANETS IN THE EVENING AND MORNING SKIES



In mid-northern latitudes, the sky appears as at the right at 8:30 a.m. on the 7th of the month, and at 7:30 a.m. on the 23rd. At the left is the sky for 6:30 p.m. on the 7th and for 5:30 p.m. on the 23rd. The moon's position is given for certain dates by symbols which show roughly its phase. Each planet has a special symbol, and is located for the middle of the month, unless otherwise marked. The sun is not shown, although at times it may be above the indicated horizon. Only the brightest stars are included, and the more conspicuous constellations.

Mercury will be at western elongation on January 31st, but its path being 4° south of the sun and at the southern part of the ecliptic in Sagittarius, its position will not be favorable for observers in northern latitudes. This elongation will be unusually favorable for residents in the tropical or south temperate zones.

Venus, in Scorpius and Sagittarius and at magnitude —3.6, will still be a bright object shortly before sunrise, but is fast losing its observational interest.

Earth, at perihelion on January 4th, will be 91,443,000 miles from the sun.

Mars, in Taurus, will cease its retrograde and begin its progressive motion on January 10th. It will be in conjunction with and 2° 49′ north of Uranus on the 20th. Its magnitude, ranging from —1.0 to —0.1 through the month, will make it appear brighter than any star seen from northern latitudes except Sirius and surpassed in brilliance only by Jupiter.

Jupiter, in Leo and 2° west of Regulus at the beginning of the month, will continue its retrograde motion.

Saturn is in Taurus.

Neptune, in Virgo, will begin its retrograde motion on January 6th.

DEEP-SKY WONDERS

THIS MONTH finds the following objects in good position for observation with moderate-sized telescopes. Descriptions are from Norton's **Star Atlas.**

Auriga. M38, $5^h\ 25^m.3$, $+35°\ 48'$. A striking, loose, cruciform cluster of stars, in a glorious region of the sky. Nearby is M36, at $5^h\ 33^m.0$, $+34°\ 7'$; an open cluster of stars with magnitudes 8 to 14, regularly arranged. It is 2° following Phi Aurigae.

M37, $5^h\ 49^m.0$, $+32°\ 33'$; a fine, open cluster, with a ruddy 9th-magnitude star near the center.

Orion. M42, $5^h\ 32^m.5$, $-5°\ 25'$. The Great Nebula in Orion, visible to the naked eye as Theta Orionis. It is a greenish, irregular, fan-shaped mass, best seen with low power. With higher powers, the bright "Huygenian" region shows a mottled appearance "like the breaking up of a mackerel sky" (Sir J. Herschel). The famous Trapezium stars are of magnitudes of 6.0, 7.0, 7.5 and 8.0, respectively.

STARS FOR JANUARY

as seen from latitudes 30° to 50° north, at 10 p.m. and 9 p.m. on the 7th and 23rd of the month, respectively. The 40° north horizon is a solid circle; the others are circles, too, but dashed in part. When facing north, hold "North" at the bottom, and similarly for other directions. This is a stereographic projection, in which the flattened appearance of the sky itself is closely reproduced, without distortion.

OBSERVER'S PAGE

All times mentioned on the Observer's Page are Eastern war time.

AN OCCULTATION OF JUPITER

BY JESSE A. FITZPATRICK

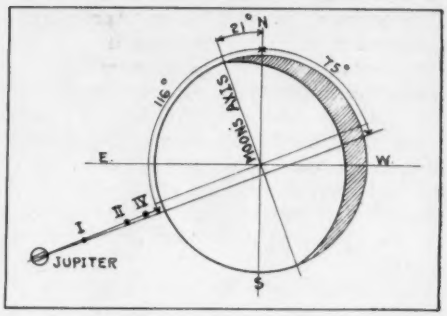
THE OCCULTATION of one of the planets by the moon is such a rare and interesting event, we can look ahead with pleasant anticipation and hopes for clear skies when Jupiter is occulted during the early morning of January 13th. This may be observed generally throughout the United States except in the west and southwest.

At our local station, the immersion will occur when the moon is one third of the way up from the horizon in the western sky, and about 20 minutes before the sun rises in the southeast. The western sky should be sufficiently dark so the immersion might be seen with the unaided eye, and surely with binoculars. In the Mississippi Valley, conditions will be more favorable, with the moon and planet higher in the sky and the sun rising more than one hour after the immersion. The times noted in the **Ephemeris** for the Standard Station near Quincy, Ill., are: immersion, 6:55.9 a.m. (C.W.T.), P.A., 138°; emersion, 7:59.1 a.m., P.A., 269°.

Since the path of the moon is in a decidedly southeasterly direction, it will pass to the north of Jupiter for observers in the far west, but interesting conjunctions may be seen. The approximate time of the conjunction, and the separation between the planet and the moon's southern edge for any local station, can be computed in 15 or 20 minutes by following the method outlined in my special article in the June, 1943, issue of **Sky and Telescope**. When the distance, 485, in my problem becomes greater than 1,080, the moon's semidiameter, there is a conjunction but no occultation. For every 72 miles that this distance is greater than 1,080, the separation is 1′ of arc, since the moon's semidiameter is approximately 15′. In this particular case, the path of Jupiter behind the moon is almost exactly perpendicular to the moon's axis, whose position angle is 21° during this occultation. Should my method be used for the timing, instead of the standard **a** and **b** quantity system used to compute the times listed in the Occultation Table, the immersion would be 30 seconds earlier and the emersion 2.5 minutes later than the times given. It is advisable for all observers to watch the moon and planet well in advance, rather than to rely on what may be only an approximate prediction of the local time of the event.

An interesting feature of this occultation will be the immersion and emersion of Jupiter's bright satellites. No. **III** will be eclipsed in the planet's shadow and then hidden in occultation and so will not appear. **I, II,** and **IV** will be seen shortly before the immersion time situated approximately as I have shown them on the diagram. I have not attempted to show this part of the picture on the same scale as the moon itself, because the relative size of Jupiter and the distances of the satellites from the primary would be too small on a drawing of this size. The angular diameter of the moon is 1,800″ and that of the planet, 44″.

The motions of the three moons will be toward the planet. **I** reaches western elongation at 3:47 a.m., and its distance will be 121″ from the center of the primary, less than three diameters of the latter. **II,** having passed western elongation



at 5:26 a.m., will still appear to be very near that position at the moment of immersion. Its distance will be 209″. **IV** will appear very close to **II,** relatively much nearer than shown on the diagram. Its distance from the center of the primary will be 218″.

It is well to remember that the actual disappearance of Jupiter behind the moon will consume about 1.5 minutes at our local station. This will vary with the longitude of the observer. The farther west one is situated, the longer will be the elapsed time. This is due to the slower apparent speed of the moon as the observer nears the longitude of geocentric conjunction, which in this case is in the Pacific Ocean not far from our west coast.

OCCULTATIONS FOR TEXAS

BECAUSE of the interest displayed last year by Texas residents, their reports submitted to Dr. Alice Farnsworth, Mt. Holyoke College, South Hadley, Mass., and the continued need for more occultation observations and observers, **Sky and Telescope** publishes this month predictions of occultations for the Texas area. Monthly publication will be continued if interest warrants.

The data given below were computed voluntarily by Miss Tecla Combariati and J. Lynn Smith, of the U. S. Naval Observatory, and sent to us by the superintendent of that institution. Predictions are for longitude 98° 0′.0 W., and latitude 30° 0′.0 north. The predictions are similar in form to those given in the **American Ephemeris** for 1944, pages 365-372. All visible occultations of stars brighter than 6.5 are given here, except those occurring within 48 hours of new moon and within 24 hours of full moon.

Due to space considerations, the occultations are not in tabular form. The data include: date, name of star, magnitude; G.C.T. in hours and minutes, **a** and **b** quantities in minutes, and position angle in degrees, at immersion; G.C.T., **a** and **b** quantities, and P.A., at emersion.

Jan. 3, 26 Ceti, 6.2; 1:50.5, —1.1, +2.3, 25°; 2:58.2, —2.2, —1.0, 273°.

Jan. 5, Mu Ceti, 4.4; 0:02.7, —1.1, +2.4, 39°; 1:20.3, —2.4, +0.8, 261°.

Jan. 9, 16 Gem., 6.1; 8:41.5, —2.2, +0.8, 56°; 9:41.5, —0.4, —2.9, 315°.

Jan. 9, Nu Gem., 4.1; 9:17.7, —0.9, —2.1, 118°; 10:24.6, —0.9, —0.5, 254°.

Jan. 13, Jupiter, —2.0; 12:29.6, +1.5, —6.2, 185°; 12:53.6, —3.0, +2.3, 224°.

Jan. 18, 566 B Vir., 6.5; 9:36.0, —1.5, +0.2, 107°; 10:57.4, —1.6, —1.3, 316°.

Jan. 31, Xi^2 Ceti, 4.3; 21:46.5, —1.7, +1.2, 79°; 23:02.8, —1.4, +2.3, 221°.

SOLAR ECLIPSE OF JANUARY 25TH

THE TOTAL eclipse of the sun on January 25th (described by Dr. Smiley in the October, 1943, **Sky and Telescope**) will be visible as a partial eclipse to those of our armed forces on the islands or mainland adjacent to the Caribbean Sea. The **American Ephemeris** notes that at Panama the eclipse will begin at 9:06 a.m. (E.W.T.) and end at 11:27 a.m., with a maximum magnitude of 53 per cent at mid-eclipse. At San Juan, P.R., the beginning is at 9:56 a.m. (60th meridian time, which is identical with E.W.T.) and the ending is at 11:49 a.m., with magnitude 21 per cent.

Approximate times for the beginning (given in 60th meridian time) and magnitude at middle eclipse for other localities in this vicinity are: Trinidad and St. Lucia, 9:50 a.m. and 50 per cent; Antigua, 10:00 a.m. and 30 per cent; Barbados, where many of our boys spend their furloughs and which was my tropical island winter home for seven years, 9:55 a.m. and 50 per cent.

In southern Texas, Louisiana, and Florida, at about 9:00 a.m. (C.W.T.) the moon will appear to have taken a small bite out of the sun. It should be watched at sunrise and for a time thereafter with proper (very dense sunglass) protection for the eyes. On page 15 is a chart showing the extent of the partial and total phases.

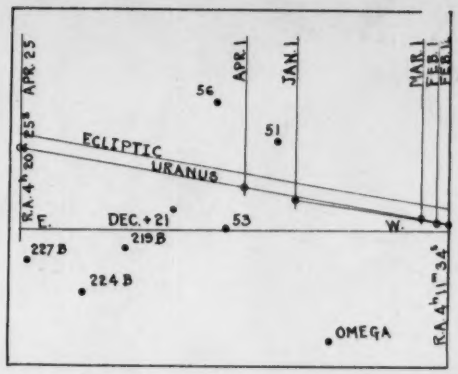
This is the only total eclipse this year. On July 20th, there will be an annular eclipse of the sun visible in the Indian Ocean, India, and the East Indies. There will be no eclipses of the moon until next year.

METEORITES FALL IN OKLAHOMA

As this issue goes to press, Oscar E. Monnig, of the Texas Observers, informs us that he is on a field trip to Oklahoma, where, on November 25th, a detonating meteor dropped meteorites near Leedey. He has direct reports of six pieces being found totaling about 26 pounds, and indirect reports of more than 20 pieces. More details will be published next month.

URANUS

THE DIAGRAM shows the path followed by Uranus in the constellation Taurus from January 1st to April 25th. Subsequent to the latter date it will be too close to the sun to be of interest. The retrograde movement continues throughout January and up to February 12th, when the planet will resume its normal progressive motion toward the east. During the period of nearly four months, Uranus will remain south of the ecliptic by an average distance of five minutes of arc.



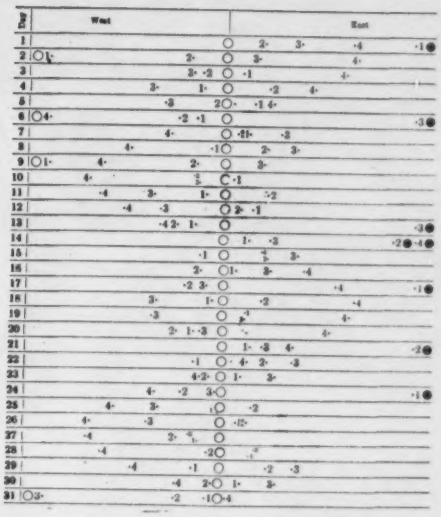
On January 6th, the planet will be in conjunction with and 40′.6 north of Omega Tauri, magnitude 4.8, the brightest star in the immediate vicinity. On March 19th, it will again be in conjunction with this star, but 1′.0 farther north.

On March 27th and April 4th and 5th, Uranus will be in conjunction successively with each of three stars which appear very brilliant in small telescopes or binoculars. The stars — 51, magnitude 5.6, spectrum **A5**; 53, 5.4, **B8**; and 56, 5.3, **A0** — are almost blue-white in color and each is brighter than 6.0, the magnitude of the planet. The latter will be 15′.5 south of 51 on March 27th; 13′.3 north of 53 on April 4th; and 24′.2 south of 56 on April 5th. These three stars, together with 224 B, magnitude 6.1, and 227 B, magnitude 5.9, form a semicircle that lies nearly midway between the Pleiades and Aldebaran — an easily found beacon that will assist the beginner in locating this interesting member of our solar system.

JUPITER'S SATELLITES

On January 9th prior to 11:37 p.m., and throughout the evenings of the 12th and 26th, the four moons will be west of the primary.

Jupiter's four bright moons have the positions shown below at 3:30 a.m., E.W.T. The motion of each satellite is from the dot to the number designating it. Transits of satellites over Jupiter's disk are shown by open circles at the left, and eclipses and occultations by black disks at the right. From the American Ephemeris.



OCCULTATIONS — JANUARY, 1944

Local station, lat. 40° 48′.6, long. 4h 55m.8 west.

Date	Mag.	Name	Immersion	P.*	Emersion	P.*
Jan. 2	6.2	26 Ceti	10:32.1 p.m.	14°	11:18.0 p.m.	296°
4	4.4	Mu Ceti	8:58.8 p.m.	46°	10:18.2 p.m.	266°
5	4.3	f Tauri	5:08.1 p.m.	119°	5:47.7 p.m.	194°
5	6.9	BD + 13° 579	10:37.3 p.m.	101°		
8	5.7	68 Orionis	10:59.7 p.m.	106°	11:59.3 p.m.	232°
9	4.1	Nu Geminorum	5:23.6 a.m.	58°	6:13.0 a.m.	313°
11	Var.	X Cancri	11:57.9 p.m.	145°	1:00.0 a.m. (12)	236°
12	6.3	BD + 17° 1979	1:13.0 a.m.	146°	2:22.7 a.m.	243°
13	—2.0	Jupiter	8:01.5 a.m.	116°	9:03.6 a.m.	285°
31	4.3	Xi² Cancri	6:45.1 p.m.	87°	7:59.4 p.m.	220°

*P is the position angle of the point of contact on the moon's disk measured eastward from the north point.

PHASES OF THE MOON

First quarter ... January 2, 4:04 p.m.
Full moon ..... January 10, 6:09 a.m.
Last quarter .... January 18, 11:32 a.m.
New moon ..... January 25, 11:24 a.m.

MINIMA OF ALGOL

January 3, 1:24 a.m.; 5, 10:13 p.m.; 8, 7:03 p.m.; 20, 6:20 a.m.; 23, 3:09 a.m.; 25, 11:58 p.m.; 28, 8:48 p.m.

★ ★

PLANETARIUM NOTES

Sky and Telescope is official bulletin of the Hayden Planetarium in New York City and of the Buhl Planetarium in Pittsburgh, Pa.

★ **THE BUHL PLANETARIUM** presents, in *January*, STARS OF A WINTER'S NIGHT.

Visitors are given an opportunity in this sky show to sit under the crisp, sparkling skies of winter, and renew their acquaintance with Orion and the Dog Star, with Taurus and the Twins, and all the other stars that stud the January heavens. We see the ancient pictures traced in the stars by sky watchers of long ago, and hear the quaint legends which were woven around them. We also make use of the great telescopes of today, to see the marvels of the universe as unveiled to the astronomer of modern times.

★ **THE HAYDEN PLANETARIUM** presents, in *January*, STARS OF A WINTER NIGHT. (See page 5.)

In *February*, THE STORY OF THE EARTH. The most important heavenly body (to us, at least) is the earth. This month we take an objective look at our own planet. How do we know its size and shape? What is its place among its neighbors and how did it get there? What of its origin and its destination? We may not answer these and other questions, but we can at least discuss them, and illustrate in the planetarium demonstration many of the physical laws that govern our planet.

★ SCHEDULE BUHL PLANETARIUM

Mondays through Saturdays (except Tuesdays) .....3 and 8:30 p.m.
Sundays and Holidays .....3, 4, and 8:30 p.m.
(Building closed Tuesdays)

★ STAFF—*Director*, Arthur L. Draper; *Lecturer*, Nicholas E. Wagman; *Manager*, Frank S. McGary; *Public Relations*, John F. Landis; *Chief Instructor of Navigation*, Fitz-Hugh Marshall, Jr.; *Instructor, School of Navigation*, Edwin Ebbighausen.

★ SCHEDULE HAYDEN PLANETARIUM

Mondays through Fridays .....2, 3:30, and 8:30 p.m.
Saturdays .....11 a.m., 2, 3, 4, 5, and 8:30 p.m.
Sundays and Holidays .....2, 3, 4, 5, and 8:30 p.m.

★ STAFF—*Honorary Curator*, Clyde Fisher; *Curator*, William H. Barton, Jr.; *Associate Curator*, Marian Lockwood; *Assistant Curator*, Robert R. Coles (on leave in Army Air Corps); *Scientific Assistant*, Fred Raiser; *Lecturers*, Charles O. Roth, Jr., Shirley I. Gale, John Saunders.